Received: 14 December 2018 | Revised: 27 October 2019 | Accepted: 1 November 2019

DOI: 10.1002/smr.2243

RESEARCH ARTICLE - METHODOLOGY

WILEY Journal of Software: Evolution and Process

A framework for modelling structural association amongst barriers to software outsourcing partnership formation: An interpretive structural modelling approach

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Funding information
Fundamental Research Funds for the Central Universities, Grant/Award Numbers: 2462020YJRC001 and 2462018YJRC040; National Natural Science Foundation of China, Grant/Award Number: 61972414; National Key Research and Development Program of China, Grant/Award Number: 2018YFB1003800

Abstract

Software Outsourcing Partnership (SOP) is considered as a type of risk and reward sharing relationship between a client organisation, in the developed countries, and its overseas vendor organisation. Regardless of numerous benefits, the development of SOP still remnants in its infancy stage due to several interactive barriers. Some studies have been conducted to examine the barriers to SOP formation. However, no attempt has been reported so far to explore the multifaceted interrelationships amongst them. To bridge the gap, this study implements Interpretive Structural Model (ISM) approach to reconnoitre the interrelationships amongst the barriers in the context of SOP formation. The objective of this research paper is to develop a framework for modelling structural association amongst the barriers. To achieve the objective, we used a hybrid methodology based on systematic literature review (SLR), empirical survey, and ISM. Firstly, via SLR study, we identified 27 barriers to SOP formation. Secondly, to empirically explore the interrelationships amongst the identified barriers, a questionnaire survey was performed with 50 experts from a total of 20 different countries. Further, interrelationships amongst the barriers were identified using ISM via panel review, and their classifications were carried out via Cross-Impact Matrix Multiplication Applied to the Classification Approach.

KEYWORDS

client-vendor relationship, contract renovation, empirical study, interpretive structural modelling (ISM), software outsourcing partnership, systematic literature review

1 | INTRODUCTION

Software development outsourcing (SDO) is a corporate business strategy adopted from the last two decades and is growing towards its maturity.[1] It may be simply defined as a bond, between client and vendor, to engineer better and cheaper software across national borders. The bond normally involves clients from advanced countries and vendors from developing countries to engineer better and cheaper software at the vendor site to be delivered to the client.[1]

There are numerous tasks in software development, such as software architecture and design, programming, and software testing, which can be outsourced. SDO offers many benefits to client organisations.[2] Small to medium sized organisations with limited technical expertise and resources are best served by outside service providers. Large organisations may also use outsourcing approach to work with new information and communication technologies (ICTs) without making any further investment.[1] Large organisations may exercise SDO due to unavailability of

in-house software development capability and to reduce processing costs.[3] However, the scope of SDO is expanding. Today's organisations not only outsource to reduce cost but to improve the company's overall working performance.[4]

Meanwhile, different kinds of companies having different types of requirements, consequently, considerably many varieties of associations are obligatory.[5] SDO organisations nowadays use a diversity of methods to outsource software development tasks such as they subcontract, develop in-house, broaden in-house competence via acquirements form joint ventures, and shape partnerships with overseas organisations.[5] Due to big economic changes, globalisation, antagonism from low remuneration unindustrialised countries, and improvements in ICTs, from 1980 onwards numerous business networks have been formed such as multisourcing, strategic networks, different kinds of alliances, coalition, association, joint-ventures, and partnership etc..[6] Organisational relationships in these networks go beyond the traditional order and supply trades.[7] In this type of relation, everything like profits, losses, investments, risks, and work burden are distributed amongst the partners' organisations.[8]

Collaborative relationships are typically divided into associations, alliances, coalitions, and joint ventures.[9] A relationship with high trust and low contractual control in enforcing the contract is called an alliance.[9] Outsourcing partnership is a category of an alliance.[10] It is that category of an alliance, which is a combination of both outsourcing and partnering. Therefore, a thorough understanding of both terms is required to understand the combined term outsourcing partnership. Kinnula et al[8] expressed outsourcing as *"The process of transferring the responsibility for a specific business function from an employee group to a non-employee group."* Outsourcing partnership is an indispensable measure of today's business success because it is over passing the conventional old-style organisational boundaries.[8] A partnership is a long-lasting bidirectional association where confidential data regarding future plans and schemes are shared with each other willingly.[11]

In the article at hand, Software Outsourcing Partnership (SOP) is defined in this way *"a long-lasting bi-directional risk and reward sharing mutually beneficial relationship between client and their overseas vendor based on mutual trust resulting from a process of shifting the responsibility of developing a software for a particular business function from an employee group to a non-employee group including transfer of assets such as personnel"*.[8] In SOP, an organisation develops mutually beneficial policies and plans.[8] In this type of relationship, stakeholders openly share risks, rewards, and workload.[12] It lets the client and vendor focus on their resources in the right track.[11]

1.1 | Research objective

The objective of this research paper is to develop a framework for modelling structural association amongst a list of barriers that are obstacles for vendors in the renovation or upgradation of their ongoing contractual outsourcing relationship into a partnership. To achieve our objective, this study implements Interpretive Structural Model (ISM) and Matrice d' Impacts Croises—Multiplication Appliqué a Classement (MICMAC) approach to reconnoiter the interrelationships amongst the barriers. For this purpose, we have executed an empirical survey based on the initial findings of the SLR. The SLR findings were used as input for the empirical survey while the findings of the empirical survey were used to develop ISM-based SOP barriers association (SOPBA) model. For ISM study, from the participants of the major survey, a panel of 10 experts was selected based on their experiences.

The following research questions were addressed:

RQ1. What are the critical barriers, as reported in the literature, that restrict outsourcing clients from renovation or upgradation of their existing contractual outsourcing association into an outsourcing partnership with vendor organisation?

RQ2. What are the critical barriers, as reported by the experts through empirical survey that restrict outsourcing clients from renovation or upgradation of their existing contractual outsourcing association into an outsourcing partnership with vendor organisations?

RQ3. What are the interrelationships amongst the identified barriers?

RQ4. What are the driving and dependence power of the identified barriers?

We have published the SLR protocol with initial results related to RQ1 in a conference paper.[13] This is an extended version of the conference paper in which we have revised the SLR results by increasing sample size from 65 to 106. For this purpose, do manual search and extend the time period from September 2016 to March 2018 while applying the same search string. Further, some novel results based on the empirical survey from RQ2 to RQ4 are also presented in this paper. Specifically, in this paper, we have extended our work by adding the following details:

- In response to RQ 1—based on the SLR, a complete result with comprehensive explanation are presented in Section 4.1.
- In response to RQ 2—based on the SLR results, a questionnaire survey was executed. We present the results and analysis based on the empirical study in Section 4.2.
- In response to RQ 3—ISM approach was used to inter-relate the barriers. We present the results and analysis based on the ISM-based study in Section 4.3.

- In response to RQ 4—MICMAC technique was used to classify the barriers. We present the results and analysis based on the empirical study in Section 4.4.

The overarching goal of the research project is to develop a barrier evaluation and mitigation model to be used by SDO vendor organisations. This model will assist SDO vendor organisations in measuring and improving their outsourcing readiness prior to starting outsourcing partnership formation or contract renewal activities.

1.2 | Paper outline

The paper is organised as follows: Section 2 presents background and motivation. Section 3 describes the research methodologies. Section 4 presents the results. Section 5 summarises and discussed the results. Section 6 discussed the limitations of the study, while Section 7 concludes the paper by mentioning future work.

2 | BACKGROUND AND MOTIVATION

In the past two decades, to stay in the market competition, outsourcing partnerships have arisen as one of the important mechanism for growing organisations.[11,14] Partnerships can benefit organisations to carry on competing by increasing competences,[14] developing innovative products,[11] connecting to new markets,[15] and gaining access to new resource pool.[16] At present, numerous new companies get involved in the global outsourcing of products and services.[11] For instance, to increase benefits and overcome problems, many organisations have established partnerships. These include Universal Postal Service and Motorola,[17] Kodak and digital equipment corporation, and IBM,[18] Shenzhen development bank and Hi Sun,[19] United States Achievement Academy and IBM,[18,20] Electronic data systems and Xerox,[20] Price-water-house-coopers and KPMG,[21] EC_Gate and Cap_Gemini,[21] Cisco, Corio, Sun, and DELL,[21] and Microsoft Net store, and US internetworking.[21] In view of Ross et al,[22] previous research does not report reasons and factors of partnership formation.

Client organisation typically creates SOP with counterpart vendor organisation for access to new technology, markets, and complementary skills, or to reduce uncertainty and to improve profit and product quality.[23] Cost saving is a good-looking aspect (outsourcing might save half of the development cost or even more), but what if the budget will be misused (you get a software with very merciless quality).[24] Regardless of numerous benefits, the development of SOP still remnants in its infancy stage due to several interactive barriers.

Engaging in partnership with other firms might decrease firms' developmental cost. A study carried out by Piltan et al[25] found that above 80% of CEOs believed that outsourcing partnerships were the core source of generating nearly 26% of their company revenues. However, SOP is not a risk-free trade; significant numbers of failure cases have also been reported.[26-28] According to the literature,[5,25,29] outsourcing partnership has a high disappointment rate. According to King,[27] JP Morgan did not renew its $5 billion outsourcing contract with IBM. The main cause of failure is the extra complexity introduced in software development projects due to outsourcing.[30] Erickson et al[28] have described the case of one SDO project which completely failed due to the problems with meeting expectations of the client on schedule, budget, and quality. Bamford et al[7] and Piltan et al[25] reported the failure ratio of outsourcing partnerships from 30% to 70%. Several risks for partnership formation have been reported in the academic literature, with more concentration on the vendor opportunism, service disagreement, extreme dependency on a vendor, financial loss and erosion of capabilities like core skills, personnel, and innovative capabilities.[31]

Kinnula et al[8] argue that previous research does not report how a partnership is formed. According to Ren et al,[18] preceding literature on outsourcing partnerships have used social theories of commitment and trust to explain the relationship phenomenon. However, only few studies have examined the determinants of partnerships. Further, preceding researchers fail to recognise the importance of pre-implementation stage factors, which may determine partnership quality.

Some studies have been conducted to examine the barriers to SOP formation such as Tuten and Urban,[32] Susarla,[33] Verner et al,[31] Chou and Pramudawardhani,[34] Aundhe and Mathew,[35] Kinnula et al,[8] Ren et al,[18] and Abdullah and Verner.[30] However, no attempt was made to explore the multifaceted interrelationships amongst them. Further, Piltan and Sowlati[25] considered partnership formation as a multicriteria decision making (MCDM) problem. Therefore, unlike other researchers, we consider the SOP formation problem as an MCDM problem. Because, several quantitative and qualitative factors impact the SOP formation decision, signposts that the SOP formation problem is an MCDM problem. ISM approach is an application of MCDM that explains the complex pattern of associations by incorporating simple notations of graph theory.[36-38] Therefore, to bridge these gaps, this study implements the ISM approach to reconnoiter the interrelationships amongst the barriers.

Additionally, we have incorporated the ISM approach to handle uncertainty, vagueness, human biases, and expert heterogeneity. According to Kou et al,[39] real-world judgment making problems are usually based on subjective data provided by the expert evaluator. According to Prodanovic,[40] in practice, experts usually have to make a decision with incomplete, imprecise, or vague data. Uncertainty in data means vagueness; it may be due to poorly defined boundaries of scale.[41] Vagueness exists in the natural language terms, such as much smaller than, much better than, good or best, important, significant, considerable, fully implemented, partially implemented, not implemented, achieved, achieving, qualified,

marginally qualified or outstanding, etc..[42,43] For the stated reasons, a good evaluation model must tolerate ambiguity or vagueness.[43-45] As each expert has a different knowledge level, complex judgment making experiences, and preference structures,[44,46] therefore, a good model must involve many field experts.[47]

To answer RQ3 and RQ4, ISM approach along with MICMAC techniques has been used. These methods transform vague, unclearly verbalised interpretive relation into visible, properly defined models valuable for many problems by imposing direction and order to the multifaceted associations.[48,49] Furthermore, in the existing studies, no SLR process has been used to systematically identify barriers from the literature before those barriers can be used in the surveys. In addition, no structural interaction model can be found to associate barriers in the SOP formation or renovation of enduring contract. Our results have complimented the studies conducted/published so far in the domain of SOP. Further, no sufficiently broad framework for the inner association amongst barriers and its ongoing classification in connection to the formation of an outsourcing partnership can be found in the relevant literature.

To address the aforementioned gaps, this study takes the issue from a vendor's perspective and targets to fill a particular gap by identifying and analysing the barriers, through systematic literature review (SLR) and empirical survey.

2.1 | Summary of the related literature on interpretive structural modelling (ISM) approach

For instance, Majumdar et al,[50] Muduli et al,[51] and Diabat and Govindan[48] analysed factors and drivers to green supply chain management, while Hussain et al,[52] explore the dimension of supply chain alternatives evaluation via ISM. Li et al,[53] Trivedi et al,[54] and Gao et al[55] applied the ISM to food and water management, Trivedi et al ,[54] to waste management, Rajaprasad and Chalapathi,[56] to safety management, and Lim et al[57] to supply chain knowledge management.

Tuan[58] explores the drivers of AIDS pandemic exploration in Africa, Potdar et al[59] explore the impediments to agile manufacturing, Awan et al[60] explore the influential factors of manufacturing sustainability, while Astri,[61] explores the factors of cloud adoption through ISM. Wu et al[62] perform supply chain performance analysis, Sajid et al[63] perform biodiesel risk factor and performance analysis, Chandramowli et al,[64] perform analysis on barriers in landfill communities, while Ravi and Shankar[37] perform reverse logistic analysis on various barriers using ISM.

Valmohammadi and Dashti[65] associate barriers to E-commerce implementation, Mishra et al[66] identify association between various practices in maintenance systems, Shen et al[67] interrelate factors of emission trading system implementation, Al-Muftah et al,[68] find interrelation amongst various factors in e-diplomacy implementation, and Gan et al[69] find structure association amongst barriers to construction site implementation using the ISM approach. A summarised view of the literature on ISM is presented in Table 1.

Although ISM approach is widely adopted by numerous investigators of different industries in a simplified way for exploring the primary and secondary connection amongst the identified influential variables, there is lack of studies that adopted ISM approach in the software engineering domain. The only study that incorporated ISM in the software engineering domain was conducted by Sharma and Sangal,[70] but their study lies outside the software outsourcing domain. Furthermore, in the existing studies, no SLR process has been used to systematically identify barriers from the literature before those barriers can be used in the empirical surveys. The ISM methodology is introduced in the next section, and its different steps are explained in details in Section 4.

3 | RESEARCH METHODOLOGY

To achieve our research objective, a hybrid research method was used as illustrated in Figure 1. Firstly, though SLR, we identified 27 barriers to SOP formation from a sample of 106 papers. Secondly, a questionnaire survey, based on the findings of the SLR, was performed with 50 experts from a total of 20 different countries to validate the SLR findings and to draw the perceptions of experts concerning the barriers. The barriers which were considered critical in SOP formation or contract renovation by experts were put forward for further analysis through ISM and MICMAC technique using expert panel review. ISM was used to draw the perceptions of experts concerning the relative inter-relationships amongst these barriers to identify the direct and indirect associations amongst the identified barriers.

These methods transform vague, unclearly verbalised interpretive relation into visible, properly defined models valuable for many problems by imposing direction and order to the multifaceted associations.[48,49] ISM methodology was formulated by Warfield in 1974,[73] as a mediating channel for complex multifaceted association amongst the factors. ISM approach is an application of MCDM that explains the complex pattern of association by incorporating simple notations of graph theory.[36-38,74] It is worth noting that, unlike Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Analytic Hierarchy Process (AHP), and Analytic Network Process (ANP) for establishing the association amongst the listed barriers, the ISM approach does not need the dominance level of the factors or barriers. This assists in decreasing the expert's prejudice and subjectivity while developing the association amongst various predictors and ultimately refining the reliability of the model. It offers a clear understanding of the model variables and assists experts to detect structure within the identified variables (barriers).[75-77] By incorporating the ISM approach, the initial reachability matrix (RM) based on the structural self-interaction matrix (SSIM) was

TABLE 1 List of various studies conducted using interpretive structural modelling (ISM) in different fields

SNO	Year	Country	Application Domain	Variable Name	Number of Variables	Author Reference
1	2019	India	Green textile supply chain management	Barriers	12	Majumdar et al[50]
2	2019	China	Water-energy-food nexus	Factors	44	Li et al[53]
3	2018	China	Consumer online group	Motivators	17	Xiao[71]
4	2018	India	E-waste management	Barriers	10	Kumar and Dixit[72]
5	2018	China	Off-site construction transformation	Barriers	13	Gan et al[69]
6	2018	UK	E-diplomacy implementation	Factors	18	Al-Muftah et al[68]
7	2018	Finland	Manufacturing sustainability	Influential factors	12	Awan et al[60]
8	2017	India	Agile manufacturing	Impediments	11	Potdar et al[59]
9	2017	Canada	Biodiesel performance analysis	Risk factors	05	Sajid et al[63]
10	2017	UK	Supply chain knowledge management	Criteria	21	Lim et al[57]
11	2017	South Africa	AIDS pandemic exploration	Drivers	11	Tuan[58]
12	2017	USA	Supply chain performance analysis	Enablers	13	Wu et al[62]
13	2016	China	Emission trading system implementation	Factors	15	Shen et al[67]
15	2016	Canada	Supply chain alternatives evaluation	Dimension	30	Hussain et al[52]
16	2015	India	Maintenance systems	Practices	24	Mishra et al[66]
17	2015	Indonesia	Cloud computing in organisations	CSFS	11	Astri[61]
18	2015	India	Waste management	Key factors	16	Trivedi et al [54]
19	2015	China	Flood management system	Alarm variables	21	Gao et al[55]
20	2015	Iran	C-commerce implementation	Barriers	04	Valmohammadi and Dashti[65]
21	2015	India	Safety management in construction organisation	Factors	09	Rajaprasad and Chalapathi[56]
22	2013	India	Green supply chain management	Factors	12	Muduli et al[51]
23	2011	UAE	Green supply chain management	Drivers	11	Diabat and Govindan[48]
24	2011	US	Development in landfill communities	Barriers	12	Chandramowli et al [64]
25	2005	India	Reverse logistic	Barriers	11	Ravi and Shankar[37]

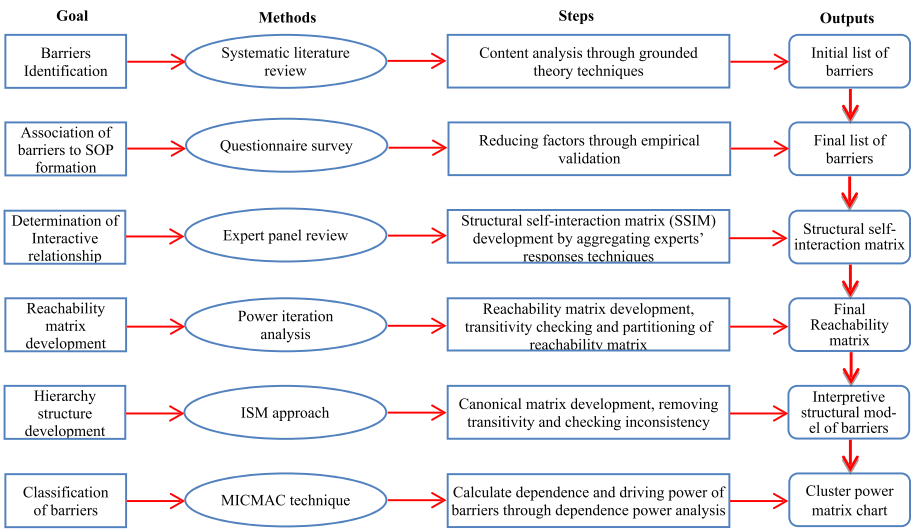

FIGURE 1 Research Methodology

obtained, which was later converted to final RM by including transitive relationships manually via power iteration analysis. Finally, these barriers were classified according to dependence and driving power using the MICMAC technique. The methodology is further explored in the following subsections.

3.1 | Data collection (Barriers identification)

The outcomes of this study are based on the data collected in three phases as presented below:

Phase 1. **(SLR):** In the first phase of data collection, various barriers that inhibit vendors to renew or upgrade their existing SDO contract-based relationships with their clients to a more trustee partnerships were identified. Prior to conduct the SLR, we had designed a review plan specifically known as a protocol. The protocol explains different phases of the SLR and can be found in our protocol paper published earlier.[13]

By using major search string, as identified in the SLR protocol, on the selected publisher sites, we found 3303 papers. Only 110 out of 3303 articles qualified the inclusion/exclusion measures. Finally, the duplication was detached by excluding four articles from the finally selected list of articles, which appeared in more than one sources. We got a final sum of 106 articles. To decrease the primary reviewer's bias, the inter-rater reliability was checked by taking 20 randomly selected papers from the primarily selected papers. The two secondary reviewers applied the inclusion/exclusion and quality criteria to make the final selection. Likewise, the two secondary reviewers also selected 20 articles retrieved through different sources, and an initial selection was made based on the title, keyword, and abstract. We used nonparametric Kendall's coefficient of concordance (W) to evaluate the inter-rater agreement between primary and secondary reviewers. Kendall's W ranges from Zero (complete disagreement) to one (complete agreement).[78] The outcomes of SLR study are presented in Table 3.

Phase 2. **(Empirical survey):** In the second phase, we have steered an empirical investigation through an online survey using the online survey tool, ie, Google Drive, in the software outsourcing industry. The purpose of the survey is twofold: (a) to validate the SLR outcomes and (b) to gain the opinions of the experienced professionals working in the industry regarding the criticality of the barriers in the background of SOP using their expertise. Our study should be considered mainly qualitative. The purpose of qualitative research is to obtain a general idea of a multifaceted area by exploring it.[79] Questionnaire assessment is mainly considered qualitative because it is a suitable method for gathering and assessing qualitative data. It gives opportunities for exploration and conversation of new themes that arise in the course of data collection. Questionnaire survey gives substantial autonomy to the investigators in pre-arrangement of inquiries. In the below subsections, we describe the process of designing and data gathering.

3.1.1 | Designing an online questionnaire survey

Based on the findings of the SLR, we designed a questionnaire. The design of a questionnaire survey normally comprises two phases, sampling, and design. Discovering, listing, selecting, and approaching the suitable field's experts to contribute to the questionnaire based survey is known as sampling.[80] The design phase consists of a set of questions for the sample (contributors) to be answered by them. Both are described briefly in the below subsections.

Sampling

We have two choices for sampling A) Methodical approach and B) Nonmethodical approach.[80] Using the first approach, samples are obtained directly from the population available with the help of certain statistics. While approach B is used, when the entire population is difficult to list.[80] We have used approach B because in our survey it was impossible to list all the software houses involved in outsourcing. Other scholars like Khan et al,[1] Cox et al,[81] and Niazi et al[82] used a similar approach.

Input to the questionnaire

The barriers identified through SLR were taken as inputs to the questionnaire.

Parts

It is divided into three dissimilar sections, ie, demography, a list of 27 barriers to be evaluated by seven points Likert scale, and submission instruction.

Question type

We have incorporated a mixture of open and close-ended questions.

Evaluation scale for the major survey

Seven points Likert scale, ie, 7-EDA (Extremely Disagree), 6-MDA (Moderately Disagree), 5-SDA (Slightly Disagree), 4-NS (Not Sure), 3-SA (Slightly Agree), 2-MA (Moderately Agree (MA), and 1-EA (Extremely Agree).

Besides this, open-ended questions like to mention barriers which are not listed were also provided.

Testing

The questionnaire design was piloted through six members of our laboratory and necessary changes were made accordingly.

3.1.2 | Data Gathering

Survey inquiry is deliberated a suitable method of gathering tacit qualitative and quantitative data.[79] The questions of the questionnaire are of two types. Open-ended also called subjective and close-ended also called objective. The subjective questions allow a variety of answers from the respondents' side while for objective only the choice can be chosen from the available choices. This method of data gathering assists in reducing the threat of bias relating to the investigator's prejudices. It encourages the respondent to give her/his own view regarding a specific question.[79,80]

Questionnaire Procedures

Prior to a questionnaire, each participant was sent a questionnaire invitation letter. This letter outlined the main themes to be covered during the questionnaire survey, the expected duration, and measures which could be taken to ensure privacy and confidentiality. The outcomes of the empirical survey are presented in Table 4.

Phase 3. **(Expert panel review):** The 3rd phase of data collection was obtaining the structural association amongst the barriers through expert panel review. ISM was used to draw the perceptions of experts concerning the relative inter-relationships amongst these barriers to identify the direct and indirect associations amongst the barriers. For this purpose, we identified a panel of 10 experts from the respondents of the survey, based on their expertise and experience in outsourcing. Only barriers to which the majority of the experts agreed in the survey were considered for further analysis through ISM technique. To develop pair-wise associations amongst the barriers, experts were asked to give their opinions based on four options (achieved by, leads to, bidirectional, no relation), across the rows and columns of the table listing barriers. The result was then translated based on Table 2

3.2 | Interpretive structural modelling (ISM)

ISM approach is an application of MCDM that explains the complex pattern of association's by incorporating simple notations of graph theory.[36-38] It is based on an interpretive methodology (created based on the opinions of the industrial and academic experts) for creating the relative associations amongst the identified barriers that may be related or isolated and which positively or negatively affect a problem or an issue of interest to the research community.[75-77] It is worth noting that, unlike TOPSIS, AHP, and ANP for establishing the association amongst the listed factors, the ISM approach does not need the dominance level of barriers. This assists in decreasing the expert's prejudice and subjectivity while developing the association amongst various predictors and ultimately refining the reliability of the model. It offers a clear understanding of the model variables and assists experts to detect structure within the identified variables.[75-77]

A complete flow diagram of ISM and MICMAC-based analysis methodology is illustrated in Figure 2. With reference to the studies[50,53,57-60,62,63,67-69,71,72] listed in Table 1, the steps involved in the ISM methodology are given below:

Step 1. Identification of barriers through SLR and survey

To identify variables related to the issues or problems under consideration, in the first step, various barriers to SOP formation were identified via SLR and empirical survey.

Step 2. Development of structural self-interaction matrix (SSIM)

TABLE 2 Linguistic terms for associating barriers

Linguistic Terms	Meaning	Corresponding Symbols
Achieved by	Barrier ***a*** will help to achieve barrier ***b***	V
Leads to	Barrier ***a*** will lead to barrier ***b***	A
Bidirectional	Barrier ***a*** and ***b*** will achieve each other	X
No relation	Barrier ***a*** and ***b*** have no relation to achieve each other	O

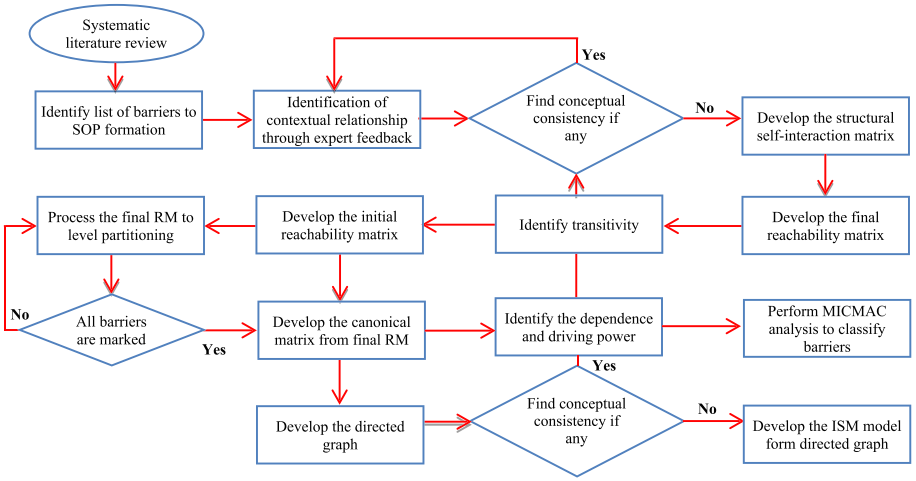

FIGURE 2 Analytical framework for analysing and modelling structural associations among barriers to SOP formation

TABLE 3 Barriers identified through SLR

Code	Name of Barrier	F	%
B1	Vendor opportunism and low mutual trust	87	82%
B2	Communication gap and poor client-vendor coordination	81	76%
B3	Relational risk and poor relationship management	78	74%
B4	Insufficient quality of technical capability	77	73%
B5	Poor infrastructure	77	73%
B6	Poor quality of service and lack of co-monitoring	75	71%
B7	Organisational differences	73	69%
B8	Hidden cost and high anticipated switching cost	68	64%
B9	Lack of psychological contract and poor contract management	64	60%
B10	Poor knowledge sharing management and cooperation between partners	62	59%
B11	Insufficient knowledge of the client activities and lack of domain training	62	59%
B12	Volatile requirement and poor requirement change control	52	49%
B13	Strategic inflexibility and ineffective dispute resolution mechanism	51	48%
B14	Poor estimation and lack of capacity to deliver product under strict time schedules	46	43%
B15	Geopolitical risk and country instability	45	43%
B16	Misaligned goal and power difference	45	43%
B17	Sign of uncertainty and lack of uncertainty absorption mechanism	45	43%
B18	High staff turnover and lack of human capital management expertise	44	42%
B19	Poor project management and lack of comanagement infrastructure	44	42%
B20	Information leakage and lack of intellectual property right protection	37	35%
B21	Incompatibility and lack of interfirm adaptation	36	34%
B22	Vendor financial instability and no relation specific investment	36	34%
B23	Lack of control over the project	30	28%
B24	Problems stemming from organisational restructuring	27	26%
B25	Poor leadership and lack of top executive support	27	26%
B26	Weak social capital and lack of social networking	27	26%
B27	Client concentration and other client specific risks	13	12%

TABLE 4 Summary of the barriers from experts' perspective

		Experts' Observation (n = 50)											
		Positive (P)					Neutral (N)		Negative (N)				
Code	Barriers	EA	MA	SA	X	%age	Y	%age	SDA	MDA	EDA	Z	%age
B1	Vendor opportunism and low mutual trust	08	15	17	40	80%	04	08%	03	02	01	06	12%
B2	Communication gap and poor client-vendor coordination	27	14	03	44	88%	03	6%	03	0	0	03	06%
B3	Relational risk and poor relationship management	27	15	01	43	86%	04	8%	03	0	0	03	06%
B4	Insufficient quality of technical capability	37	04	04	45	90%	05	10%	0	0	0	0	0%
B5	Poor infrastructure	38	04	03	45	90%	05	10%	0	0	0	0	0%
B6	Poor quality of service and lack of comonitoring	38	04	04	46	92%	02	04%	02	0	0	02	4%
B7	Organisational differences	19	15	10	44	88%	01	02%	05	0	0	05	10%
B8	Hidden cost and high anticipated switching cost	15	14	10	39	78%	02	04%	06	02	01	09	18%
B9	Lack of psychological contract and poor contract management	22	17	02	41	82%	04	08%	05	0	0	05	10%
B10	Poor knowledge sharing management and cooperation between partner	14	11	12	37	74%	06	12%	04	03	0	07	14%
B11	Insufficient knowledge of the client activities and lack of domain training	16	14	11	41	82%	04	08%	04	01	0	05	10%
B12	Volatile requirement and poor requirement change control	18	10	08	36	72%	06	12%	07	01	0	08	16%
B13	Strategic inflexibility and ineffective dispute resolution mechanism	6	15	15	36	72%	05	10%	06	02	01	09	18%
B14	Poor estimation and lack of capacity to deliver product under strict time schedules	16	14	13	43	86%	04	08%	03	0	0	03	06%
B15	Geopolitical risk and country instability	23	13	06	42	84%	04	08%	04	0	0	04	08%
B16	Misaligned goal, and power difference	10	11	12	33	66%	11	22%	05	01	0	06	12%
B17	Sign of uncertainty and lack of uncertainty absorption mechanism	12	11	09	32	64%	11	22%	06	01	0	07	14%
B18	High staff turnover and lack of human capital management expertise	13	12	09	34	68%	08	16%	07	01	0	08	16%
B19	Poor project management and lack of comanagement infrastructure	28	12	03	43	86%	03	06%	04	0	0	04	08%
B20	Information leakage and lack of intellectual property right protection	19	16	07	42	84%	04	08%	04	0	0	04	08%
B21	Incompatibility and lack of interfirm adaptation	10	14	10	34	68%	08	16%	08	0	0	08	16%
B22	Vendor financial instability and no relation specific investment	09	12	10	31	62%	08	16%	08	03	0	11	22%
B23	Lack of control over the project	20	13	04	37	74%	03	06%	08	02	0	10	20%
B24	Problems stemming from organisational restructuring	11	14	09	34	68%	08	16%	06	02	0	08	16%
B25	Poor leadership and lack of top executive support	09	16	10	35	70%	08	16%	07	0	0	07	14%
B26	Weak social capital and lack of social networking	06	13	11	30	60%	09	18%	07	02	0	09	18%
B27	Client concentration and other client specific risks	03	08	08	19	38%	17	34%	04	05	06	15	30%

Abbreviations: EA (Extremely Agree), MA (Moderately Agree), SA (Slightly Agree), SDA (Slightly Disagree), MDA (Moderately Disagree), and EDA (Extremely Disagree).

To become aware of the contextual associations amongst the barriers, in the second step, an initial pair-wise association amongst the identified barriers was developed in the form of structural self-interaction matrix (SSIM). SSIM was developed based on the experts' evaluations using the scale of Table 2 for translation.

Step 3. Development of initial reachability matrix (RM) from SSIM

The SSIM shows the direct associations amongst barriers while the RM shows both the direct and indirect relationships. Based on the SSIM, two steps were executed to develop the RM. To identify the direct relationships amongst barriers, an initial RM was obtained from the SSIM of Step 2.

Step 4. Obtain final RM from initial RM by including transitivity

The initial RM based on SSIM only shows the direct relationships amongst variables lacking the indirect associations; it is indispensable to identify indirect associations amongst barriers by checking transitivity. Therefore, in the fourth step from the initial RM, final RM was obtained by

identifying transitivity through power iteration analysis. According to Shen et al,[67] if R_f represents final RM, and R_i represents initial RM, then R_f can be obtained through Equation (1)

$$R_f = R_i^k = R_i^{k+1} \quad (1)$$

Step 5. Partition of RM into different levels

To establish the hierarchy structure and to identify various levels in the hierarchy, from the final RM of step 4, the reachability set ***R***, antecedent ***A***, *and* intersection set **R** ∩ **A** for each barrier will be obtained.

Based on set ***R***, ***A***, and **R** ∩ **A**, level partitions will be performed. To determine the level of each barrier, set ***R*** was compared with the intersection set **R** ∩ **A**.[67] Barriers for which **R** = **R** ∩ **A** will secure level 1. The variable which was marked will be discarded from the rest, and the same procedure will be repeated until all barriers were marked.

Step 6. Formation of canonical matrix and development of digraph

In this step, from the final RM of associations amongst the barriers, a canonical matrix is developed. Canonical matrix is used to draw a digraph (directed graph). A digraph is developed based on the 1's in the canonical matrix.

Step 7. MICMAC analysis techniques

To address dispersion of the barriers, MICMAC also called cross-impact matrix multiplication applied to the classification analysis technique[72] used in the last step to categorise the barriers into four categories based on the dependence power and driving power of each barrier.

4 | RESULTS AND ANALYSIS

In this section, we present the outcomes of SLR and empirical survey.

4.1 | Barriers identified via SLR (RQ1)

After getting the final sample, we extracted the data from these papers; at the last stage of the data extraction phase, we extracted a list of quotes from the final sample of 106 articles. Each primary investigator in discussion with the secondary investigators (co-authors) went through these quotes to classify these barriers into different groups. A qualitative coding approach based on grounded theory[83] was adopted to reach an initial category of barriers, and as a result, a list of 34 groups was formed. These groups were further analysed by the secondary reviewers, and some groups were combined. Finally, we came up with a list of 27 barriers as illustrated in Table 3. In Table 3, a high percentage of a barrier shows its popularity and acknowledgment in the literature. These barriers might restrict outsourcing allies from the renovation of their existing contractual outsourcing association into an outsourcing partnership.

"Vendor opportunism and low mutual trust (B1)" is the top reported barrier in our study with 82% citation in our final SLR sample. Opportunism refers to "lack of condor or honesty in trading, to include self-interest pursuing with guile".[84] "Communication gap and poor client-vendor coordination (B1, 76%)" is the second most reported barrier in our study. Communication is the interchange of unambiguous and complete information while coordination is "the act of integrating each task with each organisational unit, so the unit contributes to the overall objective. Two people have a coordination problem whenever they have common interests, or goals, and each person's actions depend on the actions of the other".[85] Language and culture barriers are well-known "communication barriers".[85]

In our SLR, 74% of the authors have stated "relational risk and poor relationship management (B3)" as a critical barrier for partnership formation. Relational risks obstruct client-vendor collaboration and thus inhibiting them from performing their responsibilities efficiently and effectively for the attainment of mutual goals.[86] This may include lack of amenability with the contract by the vendor, deterioration of service performance, quality mishaps, service deficiencies, cost overruns, and not meeting with the agreed deadlines.[87,88] Poor relationship management may be due to lack of personnel with the capability to manage a partnership.

Likewise, it was found that 73% of the included articles in our SLR study have declared "insufficient quality of technical capability (B4)" and "poor technological infrastructure (B5)" as potential hurdles for SOP. "Technical barrier" includes task complexity, poor professional skills, lack of familiarity with the outsourced technology, and lack of research and innovative ability while "technological barriers" may be due to the organisation's out-dated technology, lack of legacy and new system integration, and reluctance to use new technology.[30,31]

The sixth high quoted barrier (71% occurrence) in our SLR is "poor quality of service and lack of co-monitoring (B6)." Monitoring and control are "the process of abiding by policies, standards, goals, or quality levels".[85] Without effective monitoring in outsourcing, vendors may behave opportunistically and make choices, which will increase their benefits at the cost of clients.[89]

Likewise, "organisational differences (B7)" is mentioned by 69% of the SLR sample to be an important barrier. According to Beulen,[12] Global Sourcing Partnership (GSP) possesses some specific complications like culture and language differences, time zone, and work dispersion. According to Nguyen-Duc,[90] work dispersion can be conceptually stated as differences in the development process, experience and expertise, working environment, development tools, standards and practices, and CMMI level of organisation involved.

"Hidden cost and high anticipated switching (B8)" is claimed by sixty-four percent of the authors in our SLR as an opposing barrier for SOP formation. "Switching costs" is an important barrier for managerial decisions to continue or discontinue an outsourcing association.[91] "Hidden costs" are those costs that are not estimated or foreseen in the various phases of strategic decision making.[92]

Similarly, 52% of the included research papers reported "lack of psychological contract and poor contract management (B9)" as the main barrier. By "poor contract management," we mean rigid, fixed prices, inadequate, or incomplete contracting. In view of Abdullah and Verner,[30] a contract will be incomplete, if it neglects post outsourcing phase and fails to specify appropriate measure like nonperformance penalty. Wei et al[93] suggest a psychological contract for outsourcing. The psychological contract refers to a set of expectations concerning mutual obligations between two trading partners that are not put into black and white.[93]

"Poor knowledge sharing management (KSM) and cooperation between partners (B10)" showed 59% recognition in our SLR study. "Poor KSM and cooperation between partners' means, lack of information flow due to nonwillingness to share knowledge. The problems may be due to different levels of knowledge or problems faced in knowledge distribution.[94] The barrier is more severe when GSP involves downsizing due to resistance by the employees of the foreign client, especially to knowledge transfer.[12,35] "Insufficient knowledge of the client activities and lack of domain training (B11)" is the last barrier in our SLR which qualifies the criteria of criticality with 59% citations.

This barrier includes "lack of detailed understanding of the project sends to offshore, lack of organisational learning, and lack of training in collaboration and communication tools and functional domain. According to Verner et al,[31] functional knowledge is the understanding, experience, and expertise in the functional domain. Besides the 11 CBs, we have also listed 16 barriers such as "strategic inflexibility and ineffective dispute resolution mechanism," and "poor estimation and lack of capacity to deliver product under strict time schedules" that have a negative role in SOP formation as shown in Table 3.

4.2 | Barriers identified via empirical study (RQ2)

Based on the findings of SLR, we designed a questionnaire. Prior to the questionnaire distribution, we wrote an open invitation letter, for consent, to depict a short summary of the work. We posted an open invitation to the relevant groups on the LinkedIn (India outsourcing, outsourcing and offshoring, alliances and channels, outsourcing to India, partnership with CROs, partnership for global projects, and partnership for European projects), Facebook (software outsourcing companies and outsourcers), and Yahoo (SERG_UOM). We also sent an invitation to few selected companies from Pakistan software board (www.pseb.org.com).

We also invited the authors of the articles having industrial affiliations through email, to participate in our survey. These industry oriented articles were selected during our SLR study. In response to these invitations, a total of 101 industrial experts agreed for support. After getting their inclination the survey form web link was directed to these experts. To avoid any possible channel bias that might occur, the questionnaire was distributed using both online and onsite. This was done through Skype, Emails, Wechat, Twitter, QQ, and Instant Messengers. During predecided time bound, we acknowledged 58 filled questionnaires. We had received a rapid response to our survey request from some participants. To increase the response rate, we also sent an email reminder to the participants. This reminder helped significantly.

Upon applying the quality criteria, eight filled survey forms were rejected. After exclusion, only 50 survey forms left for further analysis. Our survey response rate was 34.65%. Barriers identified through our empirical study are shown in Table 4. Table 4 has been divided into two main columns, ie, "barriers" and "experts' observation." The "barriers" column lists down all the barriers and the "experts' observation" column records experts' experiences about each barrier which are further divided into three columns, ie, "Positive," "Negative," and "Neutral." For analysis purpose, we grouped the responses into three groups X, Y, and Z, as shown in Table 4. Group *X* counts the frequency of the positive responses (slightly agree, moderately agree, and extremely agree); group Y counts the frequency of the neutral or not sure responses while group *Z* counts the frequency of the responses responded (extremely disagree, moderately disagree, and slightly disagree). We would be remiss if we do not define "negative impact" which is as follows: "by a negative impact we mean the extent to which a certain barrier is perceived by practitioners to restrict the promotion of outsourcing partnership formation."

We suggest that outsourcing organisation should focus on these barriers to gain a partner position in the outsourcing venture for future projects. Analysing the percentage values in the "Negative" column of Table 4, we can see that most of the values are below 23% except for the "client concentration and other client specific risks"—30%. This shows that the majority of the experts had experienced the negative impact of these barriers. Similarly, in the "Neutral" column, most values are below 23% except for "client concentration" 34% which is a relatively new concept in outsourcing. Most of the respondents seem unaware of this new phenomenon. To find key barriers in this exploratory study, the below-mentioned criterion will be used:

If a barrier is answered as agreed in the questionnaire with a percentage of more than or equal to 50% then that barrier will be considered as a key barrier in this exploratory study.

The same criterion was also incorporated in our previous studies.[1,95-98] A study was conducted by Niazi et al,[99] in which they have enlisted key factors in software process improvement (SPI) with the criterion ≥50%. According to them, if a factor is reported in the literature with ≥50%, then that factor should be considered critical in SPI efforts. A comparable criterion has also been used by some other researchers.[2,82,90]

However, SDO practitioners and researchers may also delineate their own criterion to plump the criticality of the identified barriers. Based on this criterion, we drop on barrier "client concentration and other client specific risks" form further analysis via ISM and MICMAC, as discussed in the subsequent sections.

4.3 | Interpretive structural modelling (ISM) analysis (RQ3)

In this section, the outcomes related to RQ3 are presented. In the first step of our methodology, 27 barriers were identified from a sample of 106 papers through SLR. Before answering RQ3, we had validated the barriers identified through SLR using a questionnaire survey. Only 26 barriers to which the majority of the experts agreed were considered for further analysis through ISM technique. For ISM study, from the participants of the major survey, we selected a panel of 10 experts based on their experiences. To reduced single perspective bias the experts were chosen both from academia and industry. To develop a pair-wise association amongst identified 26 barriers as shown in Table 4. The experts were asked to give their opinions based on four options (achieved by, leads to, bidirectional, no relation) across the row and column.

4.3.1 | Development of structural self-interaction matrix (SSIM)

In the second step to develop a pair-wise association amongst the identified 26 barriers as shown in Table 4, an SSIM is established based on the initial association amongst the 26 barriers across row and column of Table 8 (appendix A) such that ***a*** will represent row number and ***b*** will represent column number. Symbols ***O, X, V,*** and ***A*** are used to denote the path of association amongst the listed barriers. Entry (a, b) will be mark

- when no relation exists amongst the barriers
- ***X*** when bidirectional association exist amongst the barriers
- ***V*** if barrier ***a*** will help to achieve barrier ***b***
- ***A*** if barrier ***b*** will help to achieve barrier ***a***

SSIM matrix is established on the basis of the interrelationship amongst the listed barriers. The SSIM matrix is debated with experts working in the software outsourcing industry. In view of experts, barrier "B26" (ie, weak social capital and lack of social networking) will help to address barrier "B1" (ie, "vendor opportunism and low mutual trust"), so symbol "A" is assigned. Barrier "B2" (ie, "communication gap and poor client-vendor coordination") leads to barrier "B6" (ie, "poor quality of service and lack of co-monitoring)"; therefore, it is represented by the character "V." Further, the relation between "B2" (ie, 'communication gap and poor client-vendor coordination') and barrier "B10" ("poor knowledge sharing management and cooperation between partners") is bidirectional; therefore, it is denoted by symbol "X." Both can help to achieve each other. Additionally, barrier "B4" (ie, "lack technical capability") and barrier "B2" (ie, "weak social capital and lack of social networking") are unrelated and are therefore denoted by symbol "O" and so on (see Table 8 at Appendix A).

4.3.2 | Development of reachability matrix (RM) from SSIM

To develop initial reachability amongst the barriers, initial RM is obtained from the SSIM as illustrated in Table 9 (Appendix B: Table 9 For obtaining an initial RM, the interaction established in SSIM is transformed into a binary matrix (0, 1), by replacing symbols O, X, V, and A by 0 and 1 using the rules as stated below. If the intersection of (a, b) in the SSIM is

i. O then (a, b) = (b, a) = 0 in the RM
ii. X then (a, b) = (b, a) = 1 in the RM
iii. V then (a, b) = 1 and (b, a) = 0 in the RM
iv. A then (a, b) = 0 and (b, a) = 1 in the RM

Using the four rules, mentioned above, an initial RM for barriers is developed as shown in Table 9 at Appendix B: **Table** 9. From the initial RM, final RM is derived by including the transitivity in the initial RM through power analysis using transitivity rule. Transitivity is a supposition in ISM

approach that if a barrier "X" is associated to "Y" and "Y" is associated to "Z" then "X" must be associated to "Z." The final RM is obtained from the initial RM by including transitivity manually.

Table 5 represents the final RM where 1v means forward transitivity while 1a means backward transitivity. Forward transitivity is obtained through symbol V while backward transitivity is obtained through symbol A. Table 5 also contains the driving (represented by row) and dependence power (represented by column) of each barrier along with its ranks. The calculation of driving and dependence power of barriers is based on the final RM and is defined as follow.

Driving power of barriers

To obtain the driving power of barriers, we count the number of 1's across the rows in the final RM.

Dependence power of barriers

To obtain the dependence power of barriers, we count the number of 1's across the columns in the final RM.

Ranks of barriers

We ranked the barriers based on the driving and dependence power such that an influential with highest driving and dependence power were assigned high rank.

The final RM is further used for level partitioning of the barriers for building ISM hierarchical structure, while both driving and dependence power of the barrier is used to help in conducting the MICMAC analysis.

4.3.3 | Partition of final RM into different levels

From the final RM as illustrated in Table 5, the reachability set *R* and antecedent *A* for each barrier is obtained. The final RM is partition into various levels. The procedure is as follow:

Reachability set

Set ***R*** of barriers ***a*** will contain ***a*** itself and all other barriers that help to achieve them in the row while

Antecedent set

Set ***A*** of barriers ***a*** will contain ***a*** itself and all other barriers that help to achieve them in the column.

R ∩ **A** is obtained for all barriers which give a set of barriers common in both ***R*** and ***A***.

Top level node in the hierarchy

A barrier having both reachability set ***R*** and intersection set **R** ∩ **A** the same ie, **R = R** ∩ **A** will be assign level 1**. A** top level barrier is a barrier achieved with the help of all other barriers, but it does not help to achieve any barrier. The top level barrier can be more than one influencing each other at the same level. Once top level barriers were marked, in the next step they were separated from the leftover barriers. The top level barriers are shown in Table 6.

The same procedure was repeated until all possible levels were marked. In the present study, the process was reached up to 11 iterations. Level wise results were summarised in Table 6. These levels were further used to obtain conical matrix and digraph and to structure the final ISM hierarchy. From Table 6, it is observed that both "vendor opportunism and low mutual trust" (B1) and "relational risk and poor relationship management" (B3) are marked for level-I during the first iteration. Poor quality of service and lack of comonitoring (B6), hidden cost, and high anticipated switching cost (B8), and information leakage and lack of intellectual property right protection (B20) are placed at level II of the ISM model. These were marked during second iteration. After finishing third iteration lack of technical capability (B4) and weak social capital and lack of social networking (B26) were placed at III levels. During the fourth iteration, only one barrier B23 (lack of control over the project) was isolated and put at level IV. Similarly, geopolitical risk and country instability (B15) and poor leadership and lack of top executive support (B25) were marked during the last iteration, ie, Iteration 11 and are put at the last level XI, respectively, as shown in Table 6.

4.3.4 | Formation of a conical matrix (CM) and development of digraph

A conical matrix is developed by assembling barriers at the same level across the columns and rows of the final RM. The CM helps to draw the structural model, which is illustrated in Table 7. CM will be used in the generation of the digraph. It is worth noting that in this step transitive links were removed. The initial digraph is produced with transitivity, from which a final digraph can be created by removing the indirect links. A final digraph is shown in Figure 3; this digraph will be finally converted into the ISM based SOPBA framework model, as shown in Figure 4.

TABLE 5 Final reachability matrix of the barriers

Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Driving Power	Ranks
B1	**1**	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**4**	**23**
B2	1	**1**	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	0	1_v	1	1	0	1	1	0	1	**20**	**4**
B3	1	1	**1**	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	**6**	**21**
B4	1	1	1	**1**	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**6**	**21**
B5	1_a	1	1	1	**1**	1	0	0	0	1	1_v	0	0	1	0	1_v	1_v	0	0	0	1_v	0	1_v	0	0	0	**13**	**16**
B6	1	0	1	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**	**25**
B7	1	1	1	1	0	1	**1**	0	0	1	1_v	0	1	1	1	1_v	1	0	1_v	1_v	1_v	0	1	1	0	1_v	**19**	**7**
B8	1	0	1	0	0	0	0	**1**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**	**23**
B9	1	1_a	1	1	0	1	0	1	**1**	1	1_v	0	1	1	0	1	1	0	1_v	1	1_v	0	1	0	0	1_v	**18**	**10**
B10	1	1	1	1	0	1	0	1	0	**1**	1	0	0	1	0	1	1	0	1	0	1	0	1	0	0	1_v	**15**	**14**
B11	1_a	1	1	1	0	1	1	1	1	0	**1**	1	0	0	0	1	1	0	1_v	0	1	0	1	0	0	1_v	**16**	**12**
B12	1_a	1_a	1	1	0	1	0	1	1	0	1	**1**	1	0	0	1	1	0	1_v	0	1	0	1	0	0	1_v	**16**	**12**
B13	1	0	1	1_a	0	1_a	0	1_a	0	1	0	1	**1**	0	0	1	0	0	0	0	1	0	1_v	0	0	1	**12**	**18**
B14	1_a	0	1	1	0	1	1_a	1	1_a	0	1	1	0	**1**	0	0	0	0	0	0	0	0	1	0	0	1_v	**12**	**18**
B15	1	1_a	1	1	0	1	1	1	1	1	1	1	0	0	**1**	0	1	1	1	1	1	0	1	1	0	1	**20**	**4**
B16	1	0	1	1_a	0	1	1	1	0	0	0	0	1	0	0	**1**	1	0	1_v	0	1	0	1	0	0	1	**13**	**16**
B17	1	1_a	1	1	0	1	0	1	0	1_a	1_a	1_a	1	1	0	0	**1**	0	1	1_v	0	0	1	1_v	0	1_v	**17**	**11**
B18	1_a	0	1	1	1	1	1	1	1_a	1	1	1	1_a	1	0	0	1	**1**	0	1	0	0	1	1	0	1	**19**	**7**
B19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1_a	1	**1**	1	0	0	1	0	0	1	**21**	**3**
B20	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	**3**	**25**
B21	1	1_a	1	1	0	1	1	1	1	1_a	1_a	1_a	1_a	1	0	1_a	1	1	1	0	**1**	0	1	0	0	1	**20**	**4**
B22	1	1_a	1	1	1	1	1_a	1_a	1_a	1_a	1	1_a	1_a	1_a	0	1	1_a	1	0	1	0	**1**	0	0	0	0	**19**	**7**
B23	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	**1**	0	0	1	**10**	**20**
B24	1_a	1_a	1	1	1_a	1	1_a	1_a	1	1	1_a	1	1_a	1	0	1	1	1_a	1	1_a	1	0	1	**1**	0	1	**23**	**2**
B25	1_a	1	1	1	1	1	1_a	1_a	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	**1**	1	**25**	**1**
B26	1	0	1	1_a	0	1	1	1_a	1_a	1	1	0	0	1_a	0	1	1	0	0	1	1	0	0	0	0	**1**	**15**	**15**
Dependence power	26	17	26	20	6	22	14	19	14	16	17	13	13	15	2	17	18	7	13	13	14	3	18	7	1	18	**369**	
Ranks	**1**	**9**	**1**	**4**	**23**	**3**	**14**	**5**	**14**	**12**	**9**	**17**	**17**	**13**	**25**	**9**	**6**	**21**	**17**	**17**	**14**	**24**	**6**	**21**	**26**	**6**		

TABLE 6 Final iteration-level partition of barriers

Code	Reachability Set	Antecedent Set	Intersection	Level
B1	{1, 3 10, 16}	{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26}	{1, 3 10, 16}	I
B2	{1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 19, 20, 21, 23, 24, 26}	{2, 3, 4, 5, 7, 9, 10, 11, 12, 15, 17, 19, 21, 22, 23, 24, 25}	{2, 3, 7, 9, 10, 11, 12, 17, 19, 21, 23, 24}	VI
B3	{1, 2, 3, 7, 16, 22}	{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26}	{1, 2, 3, 7, 16, 22}	I
B4	{1, 2, 3, 4, 6, 14}	{4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26}	{4, 14}	III
B5	{1, 2, 3, 4, 5, 6, 10, 11, 14, 16, 17, 21, 23}	{5, 18, 19, 22, 24, 25}	{5}	VIII
B6	{1, 3, 6}	{2, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26}	{6}	II
B7	{1, 2, 3, 4, 6, 7, 10, 11, 13, 14, 15, 16, 17, 19, 20, 21, 23, 24, 26}	{2, 3, 7, 11, 14, 15, 16, 18, 19, 21, 22, 24, 25, 26}	{2, 3, 7, 11, 14, 15, 16, 19, 21, 24, 26}	VII
B8	{1, 3, 8, 9}	{2, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26}	{8, 9}	II
B9	{1, 2, 3, 4, 6, 8, 9, 10, 11, 13, 14, 16, 17, 19, 20, 21, 23, 26}	{2, 8, 9, 11, 12, 14, 15, 18, 19, 21, 22, 24, 25, 26}	{2, 8, 9, 11, 14, 19, 21, 26}	VII
B10	{1, 2, 3, 4, 6, 8, 10, 11, 14, 16, 17, 19, 21, 23, 26}	{1, 2, 5, 7, 9, 10, 13, 15, 17, 18, 19, 21, 22, 24, 25, 26}	{1, 2, 10, 17, 19, 21, 26}	VI
B11	{1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 16, 17, 19, 21, 23, 26}	{2, 5, 7, 9, 10, 11, 12, 14, 15, 17, 18, 19, 21, 22, 24, 25, 26}	{2, 7, 9, 11, 12, 17, 19, 21, 26}	V
B12	{1, 2, 3, 4, 6, 8, 9, 11, 12, 13, 16, 17, 19, 21, 23, 26}	{2, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 24, 25}	{2, 11, 12, 13, 17, 19, 21}	VI
B13	{1, 3, 4, 6, 8, 10, 12, 13, 16, 21, 23, 26}	{2, 7, 9, 12, 13, 16, 17, 18, 19, 21, 22, 24, 25}	{12, 13, 16, 21}	V
B14	{1, 3, 4, 6, 7, 8, 9, 11, 12, 14, 23, 26}	{2, 4, 5, 7, 9, 10, 14, 17, 18, 19, 21, 22, 24, 25, 26}	{4, 7, 9, 14, 26}	VI
B15	{1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 15, 17, 18, 19, 20, 21, 23, 24, 26}	{7, 15}	{7, 15}	XI
B16	{1, 3, 4, 6, 7, 8, 13, 16, 17, 19, 21, 23, 26}	{1, 2, 3, 5, 7, 9, 10, 11, 12, 13, 16, 19, 21, 22, 24, 25, 26}	{1, 3, 7, 13, 16, 19, 21, 26}	V
B17	{1, 2, 3, 4, 6, 8, 10, 11, 12, 13, 14, 17, 19, 20, 23, 24, 26}	{2, 5, 7, 9, 10, 11, 12, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26}	{2, 10, 11, 12, 17, 19, 23, 24, 26}	VI
B18	{1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 20, 23, 24, 26}	{15, 18, 19, 21, 22, 24, 25}	{18, 24}	VIII
B19	{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 23, 26}	{2, 7, 9, 10, 11, 12, 15, 16, 17, 19, 21, 24, 25}	{2, 7, 9, 10, 11, 12, 16, 17, 19}	IX
B20	{1, 3, 20}	{2, 7, 9, 15, 17, 18, 19, 20, 22, 23, 24, 25, 26}	{20}	II
B21	{1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 21, 23, 26}	{2, 5, 7, 9, 10, 11, 12, 13, 15, 16, 21, 24, 25, 26}	{2, 7, 9, 10, 11, 12, 13, 16, 21, 26}	X
B22	{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 20, 22}	{3, 22, 25}	{3, 22}	IX
B23	{1, 2, 3, 4, 6, 8, 17, 20, 23, 26}	{2, 5, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 23, 24, 25}	{2, 17, 23}	IV
B24	{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 23, 24, 26}	{2, 7, 15, 17, 18, 24, 25}	{2, 7, 17, 18, 24}	X
B25	{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26}	{25}	{25}	XI
B26	{1, 3, 4, 6, 7, 8, 9, 10, 11, 14, 16, 17, 20, 21, 26}	{2, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 23, 24, 25, 26}	{7, 9, 10, 11, 14, 16, 17, 21, 26}	III

4.3.5 | Formation of the ISM-based structural model

ISM for barriers was obtained from the developed digraph in Figure 3, by replacing the nodes of the graph with a verbal statement in the respective barrier. The structural model displays the relationships amongst the barriers. If the relation between barriers ***b*** and ***a*** exists, then it can be discovered by an arrow pointing from ***a*** to ***b***, respectively.

TABLE 7 Conical matrix (CM)

Code	1	3	6	8	20	4	26	23	11	13	16	12	14	17	10	2	7	9	5	18	19	22	21	24	15	25	Driving Power
B1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
B3	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
B6	1	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
B8	1	1	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
B20	1	1	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
B4	1	1	1	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**
B26	1	1	1	0	1	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
B23	1	1	1	1	1	1	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**
B11	0	1	1	1	0	1	1	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**7**
B13	1	1	0	0	0	0	1	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**
B16	1	1	1	1	0	0	1	1	1	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**
B12	0	1	1	1	0	1	0	1	1	1	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**
B14	0	1	1	1	0	1	0	1	1	0	0	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**
B17	1	1	1	1	0	1	1	1	1	1	1	1	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	**13**
B10	1	1	1	1	0	1	1	1	1	1	1	0	1	1	**1**	0	0	0	0	0	0	0	0	0	0	0	**13**
B2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**1**	0	0	0	0	0	0	0	0	0	0	**16**
B7	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	**1**	0	0	0	0	0	0	0	0	0	**14**
B9	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	**1**	0	0	0	0	0	0	0	0	**16**
B5	0	1	1	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	**1**	0	0	0	0	0	0	0	**7**
B18	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	0	1	**1**	0	0	0	0	0	0	**15**
B19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**1**	0	0	0	0	0	**21**
B22	1	1	1	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	**1**	0	0	0	0	**10**
B21	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	**1**	0	0	0	**20**
B24	0	1	1	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	0	1	**1**	0	0	**17**
B15	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	1	1	0	1	1	0	1	1	**1**	0	**19**
B25	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	**1**	**22**
Dependence Power	**19**	**25**	**21**	**14**	**10**	**18**	**15**	**16**	**15**	**11**	**12**	**11**	**12**	**11**	**11**	**8**	**6**	**6**	**5**	**7**	**5**	**2**	**4**	**3**	**1**	**1**	**269**

The developed ISM model was checked and reviewed for any possible conceptual inconsistencies. The result indicates that these barriers are organised into 11 levels in the hierarchy model. Both "vendor opportunism and low mutual trust" (B1) and "relational risk and poor relationship management" (B3) is the target of the hierarchical system, and is located at the top level, which directly depends on poor quality of service and lack of comonitoring (B6), hidden cost and high anticipated switching cost (B8), and information leakage and lack of intellectual property right protection (B20). The three barriers at level II are achieved by the lower-level barriers lack of technical capability (B4) and weak social capital and lack of social networking (B26). "Lack of control over the project" (B23) is the only barriers at the fourth level. It directly depends on "insufficient knowledge of the client activities and lack of domain training" (B11), "strategic inflexibility and ineffective dispute resolution mechanism" (B13), and misaligned goal, and power difference (B16). Level II contains only two barriers, ie, lack of technical capability (B04) and weak social capital and lack of social networking (B26). Both barriers of level III can be achieved by the single barrier lack of control over the project (B23) at Level IV. Figure 4 shows the hierarchical distribution of barriers into different levels.

4.4 | MICMAC analysis techniques (RQ4)

MICMAC technique[72] was used to categorise the barriers into four categories. The categories are explained as follow:

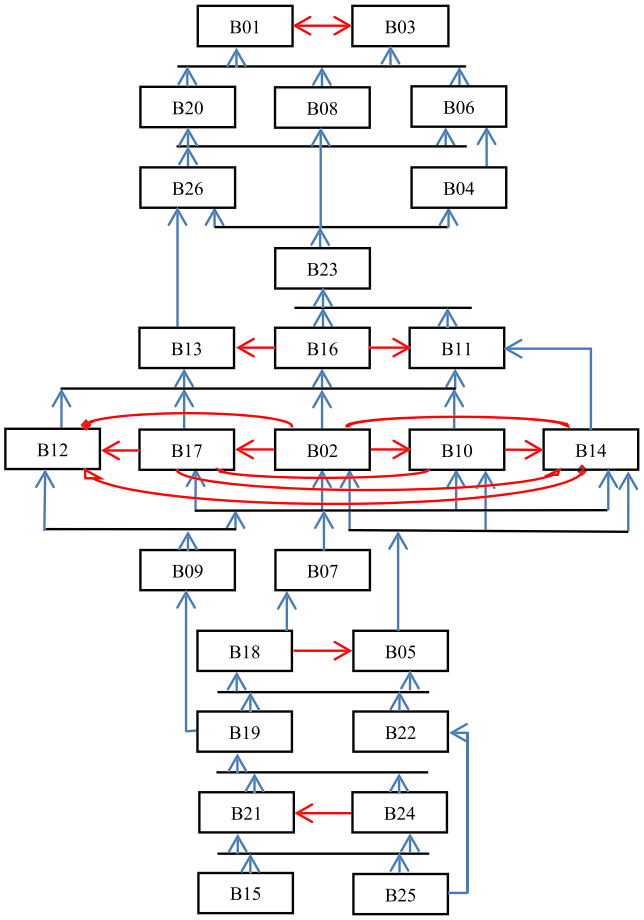

FIGURE 3 Digraph model of barriers to SOP formation

Autonomous

Barriers having both driving and dependence power as weak will be considered autonomous barriers. These are comparatively less associated to the rest. These barriers are illustrated in Quadrant-I.

Dependent

Barriers having strong dependence power but weak driving power were considered dependent barriers. These barriers are illustrated in Quadrant-II

Linkage

Barriers having both driving and dependence power as strong were considered linkage barriers. Such barriers are affected by lower level barriers in the model and in reverse; they influence the significant amount of other barriers in the model. These barriers are illustrated in Quadrant-III.

Independent

The barriers having strong driving power but weak dependence power will be considered independent barriers. These barriers are illustrated in Quadrant-IV. Figure 5 illustrates the clusters power matrix of the barriers based on the dependence and driving power. The final iteration level of each barrier is given in Table 6.

In the above figure, the red colour arrow represents the association at the same level while the sky colour arrow represent the association with others levels

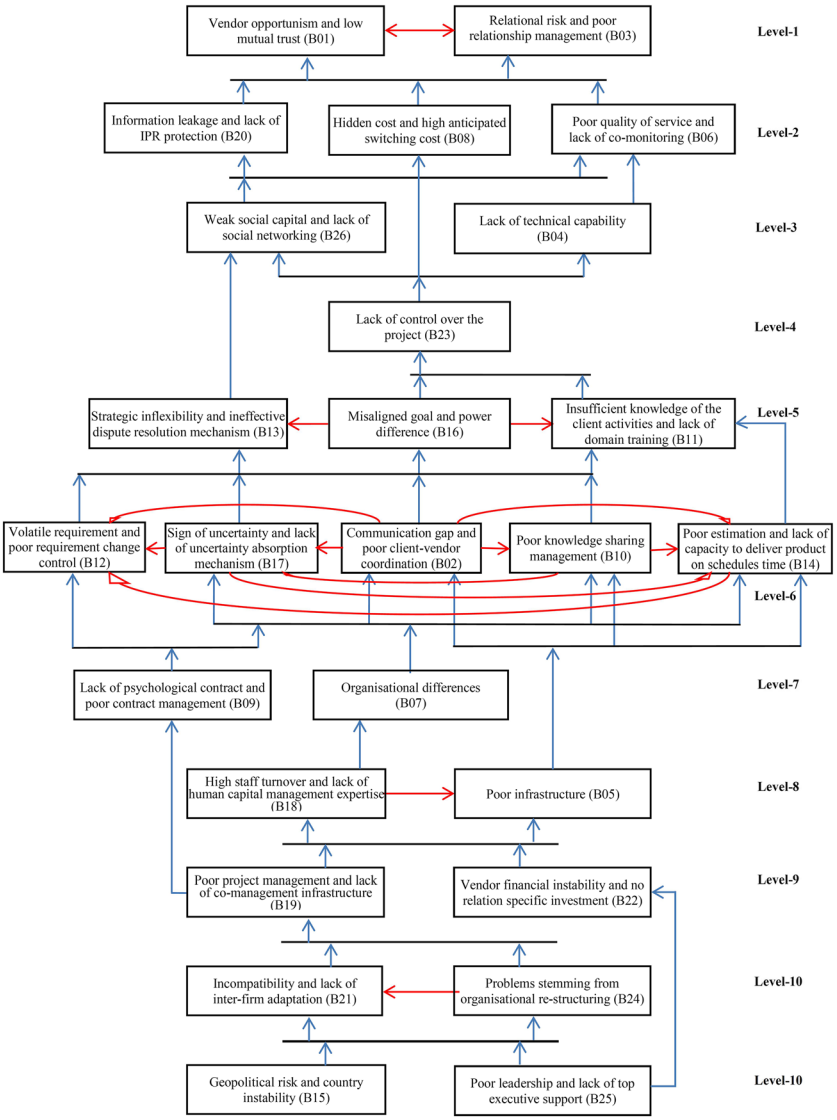

FIGURE 4 ISM-based software outsourcing partnership barriers association (SOPBA) model

5 | SUMMARY AND DISCUSSIONS

In this paper, an attempt has been made to discover different barriers connected to SOP formation. Limited work has been done on the identification of barriers to SOP formation, and no article can be found on the structured association amongst the barriers in the context of SOP. In this study, we have identified 27 barriers in total, for SOP stakeholders through SLR. These barriers may restrict outsourcing clients from renovation or upgradation of their existing contractual outsourcing associations into an outsourcing partnership with vendor organisations. Emphasis is given to key barriers, and those barriers are included in the structured hierarchical model whom significance are strongly agreed by experts in the empirical survey. Therefore, 26 barriers were put forward for further analysis of the interdependence through ISM and MICMAC techniques. Our research aims to provide SOP vendors with clear guidance that can support them to design and implement effective outsourcing partnership ventures. This research recommends that vendors should focus on all of the reported barriers as mentioned in Table 3 specifically those with high dependence and low driving power in the final RM (Table 5). Barriers signify some of the critical areas where management should focus their attentions to better design SOP initiatives.

To answer RQ1, Table 3 presents 27 barriers. These barriers play a negative role in the renovation or promotion of existing outsourcing relationship to a partnership.

To address RQ2, the experts agree to all the identified barriers except the last one B27 (client concentration) for which the positive percentage was less than 50%. Therefore, for further analysis through ISM 26 barriers were left.

In response to RQ3, the contextual relationship amongst the barriers is modelled by developing the ISM model as shown in Figure 4. The ISM model mixes the SOP barriers in a hierarchy of 11 distinct levels with the horizontal and vertical arrow showing the interrelationship amongst barriers. The top barriers are those barriers that have high dependence power but low driving power in the canonical matrix (Table 7). It means these

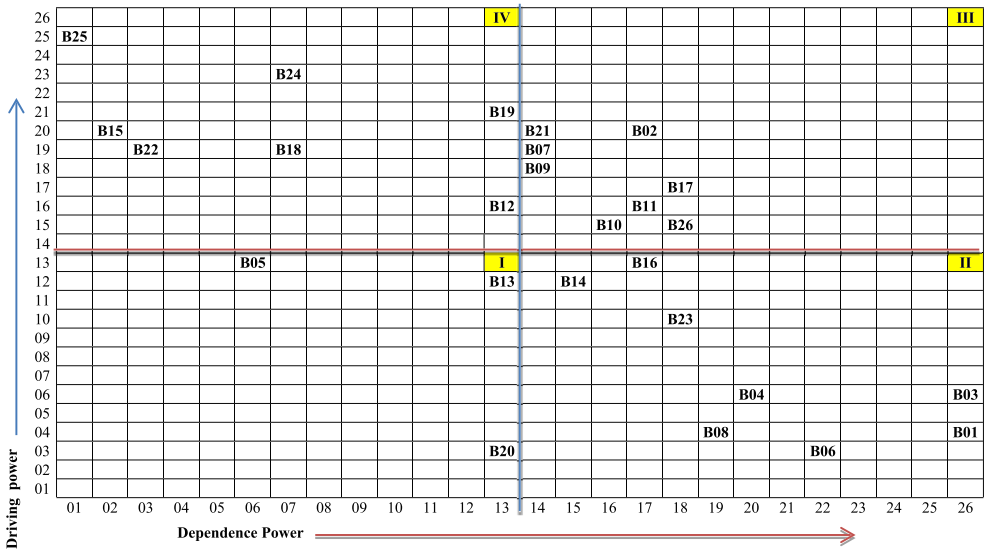

FIGURE 5 Representation of cluster power diagram for MICMAC analysis *Quadrant-IV*: Barriers under Quadrant-IV have strong driving but weak dependence power and are known as independent barriers. In this study, seven barriers were found independent. These barriers are B12 ("Volatile requirement and poor requirement change control"), B15 ("Geopolitical risk and country instability"), B18 ("High staff turnover and lack of human capital management expertise"), B19 ("Poor project management and lack of co-management infrastructure"), B22 ("Vendor financial instability and no relation specific investment"), B24 ("Problems stemming from organisational re-structuring"), and B25 ("Poor leadership and lack of top executive support").

barriers are affected by most of the barriers, but it does not affect any barrier except those at the same level. On the other hand, the bottom barriers have high driving power and low dependence power in the canonical matrix (Table 7). It means these barriers help in achieving theoretically all barriers, but it does not depend on any barrier except those at the same level.

For instance, it can be seen from Figure 4, that at level XI (from bottom) barriers B15 ("Geopolitical risk and country instability") and B25 (poor leadership and lack of top executive support) are shown. These barriers have high driving power and dependence power of only 1 in the canonical matrix (Table 7). It means these barriers help in achieving theoretically all barriers, but it does not depend on any barrier. It means country instability and poor leadership will affect most of the barriers. If it is not addressed, it is difficult to address all those who depend on it. Mukherjee et al[100] reports offshoring gives birth to this unique challenge due to geographic distance and political conditions of the partner location.

Level X also has two barriers B21 ("Incompatibility and lack of interfirm adaptation") and B24 ("Problems stemming from organisational re-structuring"). These barriers have dependence power of only 2 and 3, respectively. For instance, B21 is dependent on B15, B21, and B24, while B24 only depends on B15 and B25. It means most of the issue arising from organisational re-structuring will be connected to country instability and poor leadership. Additionally, firms will not adapt to each other unless the partner country is not stable or the partner lacks strong leadership.

Level IX consists of two barriers B19 (poor project management and lack of comanagement infrastructure) and B22 (vendor financial instability and no relation specific investment). These two barriers have dependence power of 5 and 2, respectively. B19 depends on B15, B21, B24, and B25, respectively, while B22 only depends on B25. Vendor financial instability and no relation specific investment can only be affected by poor leadership. Mehta[101] reports that "leadership and team management" requires proper experience to manage and lead teams; sometimes, they adopted improper approaches to motivate their team members. Therefore, poor leadership will result in poor project management. Further, poor leaders from client organisation fail to motivate vendors to invest.

Poor project management and lack of comanagement infrastructure may be due to country instability, poor leadership, issues of organisational restructuring, or incompatibility and lack of interfirm adaptation. Level VIII also composed of two barrier B5 (poor infrastructure) and B18 (high staff turnover and lack of human capital management expertise). B5 has a dependence power of just 5, while B18 dependence power is seven. Poor infrastructure (B5) may be due to:

i. Vendor financial instability and no relation specific investment (B22)
ii. Poor project management and lack of co-management infrastructure (B19)
iii. High staff turnover and lack of human capital management expertise (B18) or
iv. Poor leadership and lack of top executive support

Level VII contains B7 (organisational differences) and B9 (poor contract management) both have six dependence power. It means that it helps to achieve their respective six barriers. Level VI contains five barriers B2, B10, B12, B14, and B17. All these barriers have balance dependence and driving power. It means these are both diver and dependent. Level V contains three barriers namely B11, B13, and B16. These all achieve B23 at level IV which further drive B4 and B26 at level III. Level II contains B6, B8, and B20 while level I is the top level which contains barrier B1 and B3. They have a driving power of 1 and 2, respectively. These barriers have the lowest driving power while highest dependence power. For instance, B3 (relational risk and poor relationship management) is dependent on all other barriers, while it only can affect B1 (vendor opportunism and low mutual trust).

- According to Lioliou and Zimmermann,[84] vendor opportunism in outsourcing association may take several forms, for example breaching of obligations and promises, debasement of service quality in product development or service provision, distorting or withholding information regarding the project. Maintaining strong social capital and mutual trust will discourage vendor opportunism.[82]
- Ajitkumar et al[86] state that relational risks obstruct client-vendor collaboration and thus inhibiting them from performing their responsibilities efficiently and effectively for the attainment of mutual goals. This may include lack of amenability with the contract by the vendor, deterioration of service performance, quality mishaps, service deficiencies, cost overruns, and not meeting the agreed deadlines.[87,88]

For RQ4, dispersion of the barriers is addressed by performing MICMAC analysis. For the purpose of MICMAC analysis, the barriers are distributed into four quadrants as illustrated in the dependence-driving power matrix (Figure 5).

Quadrant I. The barriers under Quadrant-I have weaker driving and dependence power, therefore are known as autonomous barriers. It is clear from Figure 5 that only three barriers fall down on the extreme end of the autonomous quadrant. Autonomous barriers are poor infrastructure (B05), strategic inflexibility and ineffective dispute resolution mechanism (B13), and information leakage and lack of intellectual property right protection (B20). These barriers have no link with the overall system because of their weak linkage with the other barriers.

Quadrant II. The barriers under Quadrant-II have very weak driving power and are known as dependent barriers. In this study, eight barriers such as B01 (vendor opportunism and low mutual trust), B03 (relational risk and poor relationship management), B04 (lack of technical capability), B06 (poor quality of service and lack of co-monitoring), B08 (hidden cost and high anticipated switching cost), B14 (Poor estimation and lack of capacity to deliver product under strict time schedules), B16 (misaligned goal, and power difference), and B23 (lack of control over the project) are marked as dependent. These barriers are the ones that are influenced by independent barriers.

Quadrant III. The barriers under Quadrant-II have strong dependence as driving power and are called as linkage barriers in the MICMAC exploration. In this study, barriers such as B02 (communication gap and poor client-vendor coordination), B07 (organisational differences), B09 (poor contract management), B10 (poor knowledge sharing management), B11 (insufficient knowledge of the client activities and lack of domain training), B17 (sign of uncertainty and lack of uncertainty absorption mechanism), B21 (incompatibility and lack of inter-firm adaptation), and B26 (weak social capital and lack of social networking) are put in linkage category.

6 | LIMITATIONS

This study firstly finds barriers from a sample of 106 papers, and then empirical survey was used to inter-relate them. Further, to find significance interrelationship amongst these barriers in the SOP context, the ISM approach and MICMAC technique were used. The empirical survey was based on the results of SLR; this two-phase framework ensures content validity. Construct validity is concerned with measurement scale whether the measurement scales represent the attributes being measured. The attributes of this research study were taken from a considerable amount of previous research[2,82,90] and experiencing a SLR.[1,95-98,102] The respondents of the survey confirm the relevance of the attributes selected. Further, the inner reliability of survey responses was assessed using Cronbach's alpha coefficient which is 0.89 (>0.70), which demonstrates the reliability of data and scale. To internal validity, the SLR findings were used as input for the design of the questionnaire.

The empirical study part of this research engaged participants mainly from the Asian countries only. However, to lessen population prejudice, contributors from other countries such as North America were also invited to include diverse perspectives. Fifty experts voluntarily participated in this exploratory study, and there were no previous bonds between the participants and researchers. Contributors were informed that their participation is entirely voluntary, and they can withdraw at any time during any stage of the survey if they want. However, to ensure external validity and to diminish any possible bias, the 50 contributors were chosen from 20 different countries as presented in Table 10. Besides, most of the participants had worked in a range of small, medium, and large multinational organisations. Moreover, the participants had worked on diverse outsourcing projects from onshore to nearshore and from nearshore to offshore. Although, we cannot claim that all the contributors from these

20 countries would agree with us, however, we believe that they provide a descriptive sample. In empirical survey-based research, it is hard to obtain a fully representative sample and to deal with them in an entirely objective fashion.[103] To overcome these limitations, only those participants were included who are involved in outsourcing. The claim/relevant expertise of the participants were verified by inculcating some open-ended questions in the questionnaire which were difficult to answer by an ordinary developer or manager etc. This situation might create difficulties when contributors' judgments may be inaccurate or when outsourcing barrier supposed to have a significant inter-relation for renewal or upgradation may not, in fact, be significant at all. However, similar to others opinion-based empirical research studies,[33,98,99] we have full confidence that the findings of this research are based on the data that have been collected from the relevant participants who have been involved and have vastly diversified experience in SDO.

7 | CONCLUSION AND FUTURE WORK

The reported work contributes in the formation of a framework for modelling structural association amongst the barriers by employing a qualitative methodology for identifying the contextual inter-relationship amongst various barriers, which collectively restrict the SDO vendors from renewing or upgrading their relationships with their overseas clients. Like other researchers,[37,48,50-69,71,72] in the published literature on the association between qualitative barriers, the present study tries to fill some of the research gaps and propose a conceptual framework. This work will not only benefit the outsourcing stakeholders in understanding the indirect effects of barriers but at the same time will help them to design solutions to mitigate and control the effects of barriers that emasculate the successful contract renewal or SOP formation for the future ventures.

Similar to other researchers,[2,82,90] we conduct an empirical survey, but unlike them the present study firstly carried out a proper SLR study and identified 27 barriers to SOP formation from a sample of 106 papers. Because of the initial feedback, 26 barriers were finalised and put forward for further analysis. To identify the association amongst barriers, and to know the perceptions of experts concerning the relative relationships amongst the identified barriers, in the second phase of the empirical survey we selected a panel of 10 experts from the participants of the major survey in order to identified the structural relationship amongst barriers using ISM methodology, and as an outcome, SOPBA framework model is developed. Such a hierarchy model simplifies the categorisation and classification of the barriers as linkages, dependent, and drivers, which provides assistance to top management and decision makers. To explore the distribution effect of these barriers, MICMAC analysis was performed with the help of "cluster power matrix chart" that categories the barriers into four quadrants based on the dependence and driving power.

The barriers having low dependence and high driving power achieved the bottom position in the ISM hierarchy. For illustration, "Geopolitical risk and country instability" and "Poor leadership and lack of top executive support" are the most imperative barriers in our exploratory study. Based on the results obtained in this study, we suggest that vendors, involved in outsourcing relationships, should emphasise on all the identified barriers, specifically those appeared at bottom of SOPBA framework model, to attract clients upgrading their relationship status from vendor to partner. Besides, the SOP formation, the barriers are equally important in contract renewal. We put forward that, to gain long-lasting benefits vendor needs to move yonder than that of a client-vendor contractual agreement into a more trusted, beneficial, and collaborative arrangement called partnership.

The ISM model is of great value to the researchers and practitioners and has significant implications for both SDO clients and vendor organisations managers for devising better strategies and policies for the SOP formation. The developed model may help outsourcing stakeholders in understanding the structural correlation amongst various barriers and their role in the software outsourcing industry for SOP formation. In addition, the organisations would come to know about the driving and dependence power of barriers and the reasons why they help to achieve other or results in other barriers. Vendor organisations may benefit from this study, to know their strong and weak areas for further improvements. The proposed model is primarily developed to be used by vendor organisations. However, it is equally beneficial to client organisation as client organisation can consider the list of barriers as an evaluation criterion for vendor assessment for contract renewal or upgradation. Client organisations might use the model to gauge the vendor's capability for SOP formation or contract renewal. Vendor organisations can use these barriers as a checklist for their internal assessment. Other researchers can follow the proposed model structure and methodology to develop their own model and framework.

We invite independent research studies in this domain. From the result of this study, we have planned the following themes, as a future plan:

1. To quantify the association amongst the underlying barriers, Decision Making Trial and Evaluation Laboratory (DEMATEL) method will be used.
2. To determine, through empirical study, solutions for the identified barriers which have high driving power.
3. To find the underlying reasons, why some barriers are not linked or associated with others.
4. To determine if there exists any significant association between the identified barriers and SOP formation, expert panel review will be conducted incorporating the hypothesis testing approach.

ACKNOWLEDGMENTS

The work reported in this study is supported in part by the National Key Research and Development Program of China (No. 2018YFB1003800), the National Natural Science Foundation of China (No. 61972414), and the Fundamental Research Funds for the Central Universities (Nos. 2462020YJRC001 and 2462018YJRC040).

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REFERENCES

1. Khan SU, Niazi M, Ahmad R. Barriers in the selection of offshore software development outsourcing vendors: an exploratory study using a systematic literature review. *Inf Software Technol*. 2011;53(2011):693-706.
2. Khan SU, Khan AW. Critical challenges in managing offshore software development outsourcing contract from vendors' perspectives. *IET Softw*. 2017;11:1-11.
3. Beaumont N, Khan Z. *A taxonomy of refereed outsourcing literature*. Business and Economics: Monash University, Australia working paper; 2005.
4. Oza NV. An empirical evaluation of client - vendor relationships in Indian software outsourcing companies," PhD thesis, School of Computer Science, University of Hertfordshire, UK, 2006.
5. Moe NB, Mite D, Hanssen GK, Barney H. From offshore outsourcing to insourcing and partnerships: four failed outsourcing attempts. *Empirical Softw Eng*. 2013;19(5):1-34.
6. Venkatraman N. Offshoring without guilt. *MIT Sloan Manag Rev*. 2004;45(3):14-16.
7. Bamford J, Ernst D, Fubini DG. Launching a world-class joint venture. *Harv Bus Rev*. 2004;82:90-100, 124.
8. Kinnula M, Seppanen V, Warsta JV, Sari, "The formation and management of a software outsourcing partnership process," in 40th *Hawaii International Conference on System Sciences*, Waikoloa, HI, USA, 2007: 10.
9. Kishore R, Rao HR, Nam K, Rajagopalan S, Chaudhury A. A relationship perspective on IT outsourcing. *Commun ACM*. 2003;46(12):86-92.
10. Srinivasan M, Mukherjee D, Gaur AS. Buyer-supplier partnership quality and supply chain performance: moderating role of risks, and environmental uncertainty. *Eur Manag J*. 2011;29(4):260-271.
11. Kedia BL, Lahiri S. International outsourcing of services: a partnership model. *J Int Manag*. 2007;13(1):22-37.
12. Beulen E. The management of global sourcing partnerships: implications for the capabilities and skills of the IS function. in First Information Systems Workshop on Global Sourcing: Services, Knowledge and Innovation, Val d'Isère, France, 2007: 10.
13. Ali S, Hongqi L, Abrar MF. Systematic literature review of critical barriers to software outsourcing partnership," in 5th International Multi-Topic ICT Conference (IMTIC), Jamshoro, Pakistan, 2018: 1-8.
14. Katariina K, Ari E. Trends in industrial supply chains and networks. *Int J Phys Distrib Logistics Manag*. 2003;33:701-719.
15. Garciacanal E, Duarte CL, Criado JR, Llaneza AV. Accelerating international expansion through global alliances: a typology of cooperative strategies. *J World Business*. 2002;37(2):91-107.
16. Rothaermel FT, Boeker W. Old technology meets new technology: complementarities, similarities, and alliance formation. *Strat Manag J*. 2007;29:47-77.
17. Koh C, Ang S, Yeo G. Does IT outsourcing create firm value?," *in Proceedings of the 2007 ACM SIGMIS CPR Conference on Computer Personnel Research: The Global Information Technology Workforce*, ed St. Louis, Missouri, USA: ACM, 2007: 87-91.
18. Ren S, Bu Q, Zhou MJ, Hu CH. The influence of inter-enterprise value co-creation on innovation based on resource theories. *in The 19th International Conference on Industrial Engineering and Engineering Management*, Changsha, China, 2013: 187-196.
19. Yang BF, Zuo H, Meiyun. A case study of disaster backup outsourcing of SDB and Hi sun. in *International Conference on Electronic Commerce (ICEC)*, Xi'an, China, August 15 2005.
20. Miranda SM, Kavan CB. Moments of governance in IS outsourcing: conceptualizing effects of contracts on value capture and creation. *J Inf Technol*. 2005;20(3):152-169.
21. Kern T, Kreijger J, Willcocks L. Exploring ASP as sourcing strategy: theoretical perspectives, propositions for practice. *J Strat Inf Syst*. 2002;11(2):153-177.
22. Ross JW, Vitale MR, Beath CM. The untapped potential of IT chargeback. *MIS Q*. 1999;23(2):215-237.
23. Lee JN, Huynh MQ, Hirschheim R. An integrative model of trust on IT outsourcing: examining a bilateral perspective. *Inf Syst Front*. 2008;10(2):145-163.
24. Dyer JH, Kale P, Singh H. How to make strategic alliances work. *MIT Sloan Manag Rev*. 2001;42(4):37-43.
25. Piltan M, Sowlati T. Multi-criteria assessment of partnership components. *Exp Syst Appl*. 2016;64(1):605-617.
26. Berger H, Lewis C. Stakeholder analysis is key to client–supplier relationships of global outsourcing project success. *Int J Inf Manag*. 2011;31(5):480-485.

27. King W. Outsourcing becomes more complex. *Inf Syst Manag*. 2005;22(2):89-90.
28. Ericksen JM, Ranganathan C. Project management capabilities: key to application development offshore outsourcing. *in IEEE 39th Hawaii International Conference on System Sciences (HICSS)*, Kauai, HI, USA, 2006.
29. Khalfan A. A case analysis of business process outsourcing project failure profile and implementation problems in a large organisation of a developing nation. *Business Process Manag J*. 2013;9(6):745-759.
30. Abdullah LM, Verner JM. Analysis and application of an outsourcing risk framework. *J Syst Softw*. 2012;85(8):1930-1952.
31. Verner JM, Brereton OP, Kitchenham BA, Turner M, Niazi M. Risks and risk mitigation in global software development: A tertiary study. *Inf Softw Technol*. 2014;56(1):54-78.
32. Tuten TL, Urban DJ. An expanded model of business-to-business partnership formation and success. *Ind Market Manag*. 2001;30(2):149-164.
33. Susarla A. Contractual flexibility, rent seeking, and renegotiation design: an empirical analysis of information technology outsourcing contracts. *Manag Sci*. 2012;58:1388-1407.
34. Chou JS, Pramudawardhani D. Cross-country comparisons of key drivers, critical success factors and risk allocation for public-private partnership projects. *Int J Proj Manag*. 2015;33(5):1136-1150.
35. Aundhe MD, Mathew SK. Risks in offshore IT outsourcing: a service provider perspective. *Eur Manag J*. 2009;27(6):418-428.
36. Malone DW. An introduction to the application of interpretive structural modeling. *Proc IEEE*. 1975;63(3):397-404.
37. Ravi V, Shankar R. Analysis of interactions among the barriers of reverse logistics. *Technol Forecast Soc Change*. 2005;72(8):1011-1029.
38. Shankar R, Narain R, Agarwal A. An interpretive structural modeling of knowledge management in engineering industries. *J Adv Manag Res*. 2003;1:28-40.
39. Kou G, Peng Y, Wang G. Evaluation of clustering algorithms for financial risk analysis using MCDM methods. *Inform Sci*. 2014;275:1-12.
40. Prodanovic P. Fuzzy set ranking methods and multiple expert decision making. University of Western, Department of Civil and Environmental Engineering Facility for Intelligent Decision Support, Ontario 039, August 31, 2001.
41. Li G, Kou G, Lin C, Xu L, Liao Y. Multi-attribute decision making with generalized fuzzy numbers. *J Operational Res Soc*. 66:1793-1803, 2015/11/01 2015
42. Chang T-H, Wang T-C. Using the fuzzy multi-criteria decision making approach for measuring the possibility of successful knowledge management. *Inform Sci*. 2009;179:355-370.
43. Sangaiah A, Thangavelu A. An exploration of FMCDM approach for evaluating the outcome/success of GSD projects. *Central Eur J Eng*. 2013;3(3):419-435.
44. Kuo M-S, Liang G-S. A soft computing method of performance evaluation with MCDM based on interval-valued fuzzy numbers. *Appl Soft Comput*. 2012;12(1):476-485.
45. Kou G, Ergu D, Lin C, Chen Y. Pairwise comparison matrix in multiple criteria decision making. *Technol Econ Dev Econ*. 2016;22(2):738-765.
46. Wang Y-J. Applying FMCDM to evaluate financial performance of domestic airlines in Taiwan. *Exp Syst Appl*. 2008;34(3):1837-1845.
47. Li G, Kou G, Peng Y. A group decision making model for integrating heterogeneous information. *IEEE Trans Syst Man Cybern*. 2016;48(6):1-11.
48. Diabat A, Govindan K. An analysis of the drivers affecting the implementation of green supply chain management. *Resources, Conserv Recycl*. 2011;55(6):659-667.
49. Mandal A, Deshmukh SG. Vendor selection using interpretive structural modelling (ISM). *Int J Oper Prod Manag*. 1994;14(6):52-59.
50. Majumdar A, Sinha SK. Analyzing the barriers of green textile supply chain management in Southeast Asia using interpretive structural modeling. *Sustain Production Consumpt*. 2019;17:176-187.
51. Muduli K, Govindan K, Barve A, Kannan D, Geng Y. "Role of behavioural factors in green supply chain management implementation in Indian mining industries," *Resources. Conserv Recycl*. 2013;76:50-60.
52. Hussain M, Awasthi A, Tiwari MK. Interpretive structural modeling-analytic network process integrated framework for evaluating sustainable supply chain management alternatives. *App Math Model*. 2016;40(5):3671-3687.
53. Li G, Huang D, Sun C, Li Y. Developing interpretive structural modeling based on factor analysis for the water-energy-food nexus conundrum. *Sci Total Environ*. 2019;651(Pt 1):309-322.
54. Trivedi A, Singh A, Chauhan A. Analysis of key factors for waste management in humanitarian response: an interpretive structural modelling approach. *Int J Dis Risk Reduction*. 2015;14:527-535.
55. Gao H, Xu Y, Gu X, Lin X, Zhu Q. Systematic rationalization approach for multivariate correlated alarms based on interpretive structural modeling and Likert scale. *Chin J Chem Eng*. 2015;23(12):1987-1996.
56. Rajaprasad SVS, Chalapathi PV. Factors influencing implementation of OHSAS 18001 in Indian construction organizations: interpretive structural modeling approach. *Saf Health Work*. 6:200-205. 2015/09/01/2015
57. Lim MK, Tseng M-L, Tan KH, Bui TD. Knowledge management in sustainable supply chain management: improving performance through an interpretive structural modelling approach. *J Clean Prod*. 2017;162:806-816.
58. Tuan NT. Interpretive structural modelling in action—a preliminary exploration of AIDS pandemic in South Africa. *Procedia Eng*. 2017;182:717-724.
59. Potdar PK, Routroy S, Behera A. Addressing the agile manufacturing impediments using interpretive structural modeling. *Mater Today: Proc*. 2017;4(2):1744-1751.

60. Awan U, Kraslawski A, Huiskonen J. Understanding influential factors on implementing social sustainability practices in manufacturing firms: an interpretive structural modelling (ISM) analysis. *Procedia Manuf*. 2018;17:1039-1048.
61. Astri LY. A study literature of critical success factors of cloud computing in organizations. *Procedia Computer Sci*. 2015;59:188-194.
62. Wu WS, Yang CF, Chang JC, Château P-A, Chang Y-C. Risk assessment by integrating interpretive structural modeling and Bayesian network, case of offshore pipeline project. *Reliab Eng Syst Safety*. 2015;142:515-524.
63. Sajid Z, Khan F, Zhang Y. Integration of interpretive structural modelling with Bayesian network for biodiesel performance analysis. *Renew Energy*. 2017;107:194-203.
64. Chandramowli S, Transue M, Felder FA. Analysis of barriers to development in landfill communities using interpretive structural modeling. *Habitat Int*. 2011;35(2):246-253.
65. Valmohammadi C, Dashti S. Using interpretive structural modeling and fuzzy analytical process to identify and prioritize the interactive barriers of e-commerce implementation. *Inf Manag*. 2016;53(2):157-168.
66. Mishra RP, Kodali RB, Gupta G, Mundra N. Development of a framework for implementation of world-class maintenance systems using interpretive structural modeling approach. *Procedia CIRP*. 2015;26:424-429.
67. Shen L, Song X, Wu Y, Liao S, Zhang X. Interpretive structural modeling based factor analysis on the implementation of emission trading system in the Chinese building sector. *J Clean Prod*. 2016;127:214-227.
68. Al-Muftah H, Weerakkody V, Rana NP, Sivarajah U, Irani Z. Factors influencing e-diplomacy implementation: exploring causal relationships using interpretive structural modelling. *Govern Inf Quart*. 35:502-514. 2018/09/01/2018
69. Gan X, Chang R, Zuo J, Wen T, Zillante G. Barriers to the transition towards off-site construction in China: an interpretive structural modeling approach. *J Clean Prod*. 2018;197(3):8-18.
70. Sharma P, Sangal AL. Framework for empirical examination and modeling structural dependencies among inhibitors that impact SPI implementation initiatives in software SMEs. *J Softw: Evol Process*. 2018;30(1, no 12):e1993. https://doi.org/10.1002/smr.1993
71. Xiao L. Analyzing consumer online group buying motivations: an interpretive structural modeling approach. *Telematics Inf*. 2018;35(4):629-642.
72. Kumar A, Dixit G. An analysis of barriers affecting the implementation of e-waste management practices in India: a novel ISM-DEMATEL approach. *Sustain Product Consumpt*. 2018;14:36-52.
73. Warfield JN. Developing interconnection matrices in structural modeling. *Syst Man Cyber*. 1974;4:81-87.
74. Ali S, Li H, Khan SU, Zhao Y, Li L. Fuzzy multi attribute assessment model for software outsourcing partnership formation. *IEEE Access*. 2018;6(2018):55431-55461.
75. Hawthorne RW, Sage AP. On applications of interpretive structural modeling to higher education program planning. *Socioecon Plann Sci*. 1975;9(1):31-43.
76. Kannan G, Haq AN. Analysis of interactions of criteria and sub-criteria for the selection of supplier in the built-in-order supply chain environment. *Int J Prod Res*. 2007;45:3831-3852.
77. Pramod VR, Banwet DK. ISM for understanding the enablers of telecom service supply chain. *Int J Bus Excell*. 2015;8(5):537-565.
78. Von Eye A, Mun EY. *Analyzing Rater Agreement Manifest Variable Methods*. 1 Edition ed. New York, USA: Psychology Press; 2006.
79. Lethbridge TC, Sim SE, Singer J. Studying software engineers: data collection techniques for software field studies. *Emp Softw Eng*. 2005;10(3):311-341.
80. Creswell JW. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Los Angeles, CA: Sage Publications; 2013.
81. Cox K, Niazi M, Verner J. Empirical study of Sommerville and Sawyer's requirements engineering practices. *IET software*. 2009;3(5):339-355.
82. Niazi M, Ikram N, Bano M, Imtiaz S, Khan SU. Establishing trust in offshore software outsourcing relationships: an exploratory study using a systematic literature review. *IET Software*. 2013;7(5):283-293.
83. Corbin J, Strauss A. *Basics of Qualitative: Techniques and Procedures for Developing Grounded Theory*. 4th ed. SAGE Publications, Inc; 2014:456.
84. Lioliou E, Zimmermann A. Vendor opportunism in IT outsourcing: a TCE and social capital perspective. *J Inf Technol*. 2015;30(4):307-324.
85. Agarwal A, Singh D. Partner Relationship Management (PRM) Index: an innovative approach for enhancing channel partner relationships. *J Internet Bank Commer*. 2014;19(1):1-25.
86. Ajitkumar S, Bunker D, Smith S, Winchester D. A study of the risks in an information system outsourcing partnership. in Open IT-Based Innovation: Moving Towards Cooperative IT Transfer and Knowledge Diffusion, Boston, MA, 2008: 403-422.
87. Rhodes JH, Lok P, Loh WW, Cheng V. Critical success factors in relationship management for services outsourcing. *Service Business*. 2016;10(1):59-86.
88. Gonzalez R, Gasco JL, Llopis J. Information systems outsourcing reasons and risks: a new assessment. *Ind Manag Data Syst*. 2013;110(2):284-303.
89. Mathew SK, Chen Y. Achieving offshore software development success: an empirical analysis of risk mitigation through relational norms. *J Strat Inf Syst*. 2013;22:298-314.
90. Nguyen-Duc A, Cruzes DS, Conradi R. The impact of global dispersion on coordination, team performance and software quality – a systematic literature review. *Inf Softw Technol*. 2015;57:277-294.
91. Soderberg AM, Krishna S, Bjorn P. Global software development: commitment, trust and cultural sensitivity in strategic partnerships. *J Int Manag*. 2013;19:347-361.
92. Larsen MM, Manning S, Pedersen T. Uncovering the hidden costs of offshoring: the interplay of complexity, organizational design, and experience. *Strat Manag J*. 2013;34:533-552.

93. Wei Z, Du Z, Bao Y. Outsourcer knowledge protection, psychological contract schema, and project performance: a vendor's perspective. *IEEE Trans Eng Manag*. 2018;65(1):128-140.
94. Teo TSH, Bhattacherjee A. Knowledge transfer and utilization in IT outsourcing partnerships: a preliminary model of antecedents and outcomes. *Inf Manag*. 2014;51:177-186.
95. Ali S, Khan SU. Software outsourcing partnership model: an evaluation framework for vendor organizations. *J Syst Softw*. 2016;117:402-425.
96. Ali S, Hongqi L, Khan SU, Zhongguo Y, Liping Z. Success factors for software outsourcing partnership management: an exploratory study using systematic literature review. *IEEE Access*. 2017;5:23589-23612.
97. Ali S, Khan SU. Critical success factors for software outsourcing partnership (SOP): a systematic literature review. *in International Conference on Global Software Engineering*, Shangai China, 2014: 10.
98. Ali S, Li H, SU Khan MF, Abrar YZ. Practitioner's view of barriers to software outsourcing partnership formation: an empirical exploration. *J Softw Evol Process*. 2019;31(9):e2233. https://doi.org/10.1002/smr.2233
99. Niazi M, Wilson D, Zowghi D, Wong B. A model for the implementation of software process improvement: an empirical study," *in Product Focused Software Process Improvement (Profes 2004)*, Japan, 2004: 1-16.
100. Mukherjee D, Gaur A, Datta A. Creating value through offshore outsourcing: an integrative framework. *J Int Manag*. 2013;19:377-389.
101. Ali S, Ullah N, Abrar MF, Majeed MF, Umar MA, Huang JW. Barriers to software outsourcing partnership formation: an exploratory analysis. *IEEE Access*. 2019;7:164556-164594. https://doi.org/10.1109/ACCESS.2019.2949919
102. Mehta N, Mehta A. It takes two to tango: how relational investments improve IT outsourcing partnerships. *Commun ACM*. 2010;53(2):160-164.
103. Coolican H. *Research Methods and Statistics in Psychology*. 7th Edition ed. London: Routledge; 2018.

How to cite this article: Ali S, Huang J, Khan SU, Li H. A framework for modelling structural association amongst barriers to software outsourcing partnership formation: An interpretive structural modelling approach. *J Softw Evol Proc*. 2020;32:e2243. https://doi.org/10.1002/smr.2243

APPENDIX A

TABLE 8 Structural self-interaction (SSIM) matrix of the barriers

Code	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01
B01	A	O	O	A	A	A	A	A	O	A	X	A	O	A	O	O	X	A	A	A	A	O	A	X	A	X
B02	V	A	V	X	O	V	V	A	O	V	V	O	V	V	V	X	X	V	V	X	V	A	A	X	X	
B03	A	A	A	A	X	A	A	A	A	A	X	A	A	A	A	A	A	A	A	X	A	A	A	X		
B04	O	A	A	A	A	A	O	A	A	A	O	A	X	O	A	A	A	A	O	A	V	A	X			
B05	O	A	O	O	A	O	O	A	A	O	O	O	V	O	O	O	V	O	O	O	V	X				
B06	A	A	A	A	A	A	O	A	A	A	A	A	A	O	A	A	A	A	O	A	X					
B07	A	O	V	V	O	A	O	A	A	V	A	X	V	V	O	A	V	O	O	X						
B08	O	O	O	A	O	A	O	A	A	A	A	A	A	O	A	A	A	X	X							
B09	O	A	A	V	O	A	V	A	O	V	V	A	V	V	A	A	V	X								
B10	A	A	A	V	O	V	O	X	A	V	V	A	V	A	O	V	X									
B11	A	A	O	V	A	V	O	A	A	V	V	A	A	O	X	X										
B12	O	A	A	V	O	V	O	A	A	V	V	A	A	X	X											
B13	V	A	O	O	O	V	O	A	O	A	X	O	O	X												
B14	O	A	A	V	O	A	O	A	A	A	O	O	X													
B15	V	O	O	V	O	V	V	V	V	V	O	X														
B16	X	A	A	V	A	V	O	A	O	V	X															
B17	A	A	A	X	O	A	O	V	A	X																
B18	V	A	V	V	A	A	V	A	X																	
B19	V	A	A	V	O	A	V	X																		
B20	A	A	O	A	A	O	X																			
B21	X	A	A	V	O	X																				
B22	O	A	O	O	X																					
B23	V	A	A	X																						
B24	V	A	X																							
B25	V	X																								
B26	X																									

APPENDIX B

TABLE 9 Initial reachability matrix of the barriers

Code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
B01	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
B02	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	0	1	1	0	1
B03	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
B04	1	1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
B05	0	1	1	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
B06	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B07	1	1	1	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	0	0	0	0	1	1	0	0
B08	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B09	1	0	1	1	0	1	0	1	1	1	0	0	1	1	0	1	1	0	0	1	0	0	1	0	0	0
B10	1	1	1	1	0	1	0	1	0	1	1	0	0	1	0	1	1	0	1	0	1	0	1	0	0	0
B11	0	1	1	1	0	1	1	1	1	0	1	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0
B12	0	0	1	1	0	1	0	1	1	0	1	1	1	0	0	1	1	0	0	0	1	0	1	0	0	0
B13	1	0	1	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1
B14	0	0	1	1	0	1	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0
B15	1	0	1	1	0	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	1	0	1	0	0	1
B16	1	0	1	0	0	1	1	1	0	0	0	0	1	0	0	1	1	0	0	0	1	0	1	0	0	1
B17	1	0	1	1	0	1	0	1	0	0	0	0	1	1	0	0	1	0	1	0	0	0	1	0	0	0
B18	0	0	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	1	0	1	0	0	1	1	0	1
B19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	0	1	0	0	1
B20	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
B21	1	0	1	1	0	1	1	1	1	0	0	0	0	1	0	0	1	1	1	0	1	0	1	0	0	1
B22	1	0	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0
B23	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1
B24	0	0	1	1	0	1	0	0	1	1	0	1	0	1	0	1	1	0	1	0	1	0	1	1	0	1
B25	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
B26	1	0	1	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	1

APPENDIX C

TABLE 10 Background of the survey participants

Respondent ID	Position in the Company	Classification	Respondent Job Location	Experience in Years	Classification	Company Scope	Company Size
#1	Chief Executive Officer	Decision Maker	India	11+ years	Senior	Multinational	Large
#2	Chief Executive Officer	Decision Maker	Ireland	7 years	Intermediate	Multinational	Medium
#3	Senior System Analyst	Decision Maker	Pakistan	11+ years	Senior	Multinational	Large
#4	Project Coordinator	Manager	China	8 years	Intermediate	Both	Medium
#5	Professor	Academic Researcher	Pakistan	11+ years	Senior	National	Large
#6	Software Engineer	Developer	China	2 years	Junior	Multinational	Large
#7	Software Developer	Developer	Malaysia	4 years	Junior	Both	Medium
#8	Professor	Academic Researcher	Indonesia	12.8 years	Senior	National	Large
#9	Negotiator	Decision Maker	China	7 years	Intermediate	Multinational	Large

(Continues)

TABLE 10 (Continued)

Respondent ID	Position in the Company	Classification	Respondent Job Location	Experience in Years	Classification	Company Scope	Company Size
#10	Application Developer	Developer	China	2 year	Junior	Multinational	Large
#11	Technical Manager	Manager	China	12 years	Senior	National	Medium
#12	Programmer	Developer	Pakistan	8 years	Intermediate	National	Medium
#13	Senior Analyst	Decision Maker	China	5+ years	Intermediate	National	Small
#14	Technical Lead	Decision Maker	China	12 years	Senior	Multinational	Medium
#15	Web Developer	Developer	Pakistan	3 years	Junior	Multinational	Small
#16	Senior Outsourcing Manager	Decision Maker	Canada	5+ years	Intermediate	Multinational	Medium
#17	Senior Analyst	Decision Maker	India	11+ years	Senior	Multinational	Large
#18	Senior Contract Manager	Decision Maker	Phosphine	5+ years	Intermediate	Multinational	Large
#19	Senior System Analyst	Decision Maker	China	3 years	Junior	Multinational	Large
#20	Application Developer	Developer	China	1.2 years	Junior	National	Small
#21	Software Engineer	Developer	UK	7 years	Intermediate	National	Small
#22	IT Manager	Manager	China	13 year	Senior	Multinational	Large
#23	Requirement Manager	Manager	Pakistan	7 years	Intermediate	Multinational	Medium
#24	Development Manager	Manager	China	4 years	Junior	National	Medium
#25	Assistant Professor	Academic Researcher	Pakistan	7 years	Intermediate	National	Large
#26	System Manager	Manager	Pakistan	2 year	Junior	National	Medium
#27	Senior Software Engineer	Decision Maker	China	5+ years	Intermediate	Multinational	Large
#28	Project Coordinator	Manager	China	5+ years	Intermediate	Multinational	Medium
#29	Development Manager	Manager	USA	1.6 years	Junior	National	Medium
#30	IT Manager	Manager	Nigeria	4.6 years	Junior	National	Medium
#31	Quality assurance Manager	Manager	India	8 years	Intermediate	Multinational	Large
#32	Project Manager	Manager	Pakistan	1 year	Junior	National	Small
#33	Full Stack Developer	Developer	China	2 years	Junior	National	Small
#34	Project Manager	Manager	China	11+ years	Senior	Both	Medium
#35	President	Decision Maker	China	22 years	Senior	Multinational	Medium
#36	Chief Executive Officer	Decision Maker	Pakistan	20 years	Senior	Multinational	Large
#37	Senior Manager	Decision Maker	Saudi Arabia	7+ years	Intermediate	Multinational	Large
#38	Outsourcing Analyst	Decision Maker	Saudi Arabia	3 years	Junior	Multinational	Large
#39	PhD. Student	Academic Researcher	Saudi Arabia	4 years	Junior	National	Large
#40	Senior Outsourcing Manager	Decision Maker	Finland	11 years	Senior	National	Small
#41	Junior Manager	Manager	Yemen	1 years	Junior	National	Small
#42	Project Manager	Manager	Jordan	4 years	Junior	National	Small
#43	Project Coordinator Manager	Manager	Jordan	7 years	Intermediate	Multinational	Large
#44	Software Designer	Developer	Haiti	4 years	Junior	National	Small
#45	Test Case Manger	Manager	Australia	5+ years	Intermediate	National	Large
#46	Project Coordinator	Manager	Korea	14 years	Senior	Multinational	Large
#47	Distributed Team Leader	Manager	Russia	12 years	Senior	Multinational	Medium
#48	Project Coordinator	Manager	Japan	10 years	Intermediate	National	Medium
#49	Test Manager	Manager	Malaysia	9+ years	Intermediate	Multinational	Large
#50	Chief Executive Officer	Decision Maker	Malaysia	11+ years	Senior	Multinational	Large